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Second Preface to Volume XXXI

Faraday to Tyndall

In the year 1855 MICHAEL FARADAY was generally recognized as the foremost physicist of the world, for his main discoveries had been made in the second quarter of the century. He was then in the sixty-fourth year of his age and though he was destined to live twelve years longer, his main work was done and was more than sufficient for the glory of a single man. Two years before, JOHN TYNDALL had been appointed professor in natural philosophy at the Royal Institution and it is said that these two men collaborated in the most harmonious manner. TYNDALL though only thirty-five years old had already distinguished himself by many theoretical and experimental studies on magneto-optical phenomena and their relationship with molecular structure, on diamagnetic polarity, etc. and his Royal Institution lecture of 1853 "on the influence of material aggregation on the manifestations of force" had drawn to him the attention of the scientific public at large. In Sept. 1855 he attended the meeting of the British Association for the Advancement of Science in Glasgow and read a paper which was followed by a brisk discussion. One of his contradictors was WILLIAM WHEWELL, the master of Trinity, who liked to pontificate and was often sententious, bigoted and overbearing. TYNDALL was pained and irritated and I suspect, without being able to prove it, that it was WHEWELL who had hurt his feelings. He confided his trouble to FARADAY, who was old enough to be his father, and FARADAY wrote him the very kind letter which follows :

Sydenham, 6th Oct., 1855.

My dear TYNDALL,—These great meetings, of which I think very well altogether, advance science chiefly by bringing scientific men together and making them to know and be friends with each other; and I am sorry when that is not the effect in every part of their course. I know nothing except from what you tell me,

for I have not yet looked at the reports of the proceedings; but let me, as an old man, who ought by this time to have profited by experience, say that when I was younger I found I often misinterpreted the intentions of people, and found they did not mean what at the time I supposed they meant; and, further, that as a general rule, it was better to be a little dull of apprehension where phrases seemed to imply pique, and quick in perception when, on the contrary, they seemed to imply kindly feeling. The real truth never fails ultimately to appear; and opposing parties, if wrong, are sooner convinced when replied to forbearingly, than when overwhelmed. All I mean to say is, that it is better to be blind to the results of partisanship, and quick to see good will. One has more happiness in oneself in endeavouring to follow the things that make for peace. You can hardly imagine how often I have been heated in private when opposed, as I have thought unjustly and superciliously, and yet I have striven, and succeeded I hope, in keeping down replies of the like kind. And I know I have never lost by it. I would not say all this to you did I not esteem you as a true philosopher and friend.

TYNDALL treasured this letter and thus was able, some twenty years later, to insert it in his memoir of FARADAY (1). He could appreciate the latter's advice and follow it, for he was himself a very generous man, witness his defense of ROBERT MAYER against his own countrymen, and other noble deeds. FARADAY's advice is still timely. Men of science should give examples of equanimity and longanimity, or else what is the use of their knowledge?

Rockport, Massachusetts. GEORGE SARTON.
July 28, 1939.

(1) JOHN TYNDALL : *Faraday as a discoverer* (p. 40, London, 1873).

Some bibliographical notes and queries on Philemon Holland's translation of the Regimen Sanitatis Salerni

In course of preparing a detailed bibliography of the works of the famous Elizabethan translator and physician, PHILEMON HOLLAND, I have noticed a recurring series of apparent misstatements about one of his works. This is the Salernitan poem entitled *Regimen Sanitatis Salerni: or, The Schoole of Salernes Regiment of Health*, which Doctor HOLLAND translated into English along with the original commentary of ARNALDUS DE VILLA NOVA. There were several editions in quarto of this translation during the seventeenth century, the bibliographical relations of which are not at all clear.

Sir ALEXANDER CROKE in 1830 published an edition of Sir JOHN HARINGTON's translation of the Schola Salernitana and in his Introduction gives a "Catalogue of Printed Editions" of the poem. Here he states that HOLLAND's translation "was published in 1609, 1617, 1624, 1634, 1649, 1667. The dedication to that of 1634 is signed R. H. (RICHARD HOLLAND [but query]) and attributes it to his father PHILEMON HOLLAND, doctor of physic" (1). This dedication is indeed signed R. H. in the three copies I have seen, but in it there can be found no attribution of the work to PHILEMON HOLLAND. HALKETT and LAING (2), however, have repeated this erroneous statement, apparently on the ultimate authority of CROKE. The latter had in his possession this 1634 as well as the 1617 and 1649 editions, and it is difficult to see how so accomplished a scholar could have made such

(1) *Regimen Sanitatis Salernitanum: A Poem on the Preservation of Health in Rhyming Latin Verse... With an Ancient Translation: and an Introduction and Notes*, Oxford, 1830, p. 89.

(2) *Dictionary of Anonymous and Pseudonymous English Literature*, new and enlarged edition, Edinburgh, etc., 1929, V, p. 53.

a statement without some basis in fact. Might there have been two editions of the poem published in 1634? This possibility will now be examined.

The title-page of my copy of the 1634 edition reads : *Regimen Sanitatis Salerni :* / OR, / THE SCHOOLE / OF / SALERNES / Regiment of Health. / [Rule] / CONTAYNING / Most Learned and judicious Directions and / Instructions, for the guide and government / of Mans life. / *Dedicated vnto the High and Mighty* / King of ENGLAND, from that Vniversity, / and Published (*by consent of learned Physitians*) / for a Generall good. / Reviewed, Corrected, and inlarged with a Comen- / tary, for the more Plaine and easie vnderstan- / ding thereof. / *Whereunto is annexed, a necessary Discourse of all sorts* / of FISH, in vse among vs, with theyr effects, / appertayning to the health of Man. / [Rule] / LONDON. / Printed by B. ALSOP and T. FAVVCET, dwelling in / *Grub-street* neere the Lower Pumpe. / 1634. Collation : A-Z Aa-Gg in fours. This is the most common of the various editions of HOLLAND's translation, and the several copies I have seen recorded (including the Library of Congress copy) appear to be similar to mine. LOWNDES (3), however, catalogued a 1634 edition as follows : " Regimen Sanitatis Salerni, or the Schoole of Salerne's Regiment of Health, with Poetrie interspersed. Lond. in Grub Street, near the lower pumpe, 1634, 4to." If an edition with a title corresponding to LOWNDES' description exists, it is barely possible that its dedication might contain a definite attribution of authorship to Doctor HOLLAND.

The 1634 edition is almost identical, save for slight changes in orthography, with that of 1649, " *By* P. H. Dr. *in Physicke, deceased* " (4). The dedication to this edition reads in part : " *It* [the Regimen] *being a Work that hath heretofore passed the Presse, more than once ; but never so compleat, as now it is, it having my deceased learned Father* Dr. HOLLAND *his many emendations and additions.*" This is signed :

H. H.
Φ F.

(3) *Bibliographer's Manual of English Literature*, edited by H. G. BOHN, London, 1869, p. 2172.

(4) The 1649 edition has an additional appendix, " ... certain precious and approved Experiments for Health, by a Right Honorable, and Noble Personage," but omits the Discourse on Fish, although the title-page calls for it.

i.e., HENRY HOLLAND, PHILEMON filius. HALKETT and LAING, it may be mentioned, interpret the initials H. H. as HUGH HOLLAND, a manifest error.

The earliest edition I have been able to examine, that of 1617, reads on the title-page : " Regimen Sanitatis Salerni. The Schoole of Salernes most learned and iuditious Directorie, or Methodicall Instructions, for the guide and gouerning the health of Man. [etc.] Perused, and corrected from many great and grosse imperfections, committed in former Impressions : With the Comment, and all the Latine verses reduced into English, and ordered in their apt and due places. London, Imprinted by BARNARD ALSOP, and are to be sold by IOHN BARNES, at his shop in Hosier Lane. 1617." The dedication, signed " Anonymvs," is to IOSEPH FENTON, Esquire, " a Gentleman skilfully experienced both in Physicke and Chirurgery," and contains these significant sentences : " I send you this new olde Booke,... All my paines hath beene, to purge it from infinite absurdities committed in precedent impressions, and adding of the Latine verses in English, according to my capacity and best ability." The phrasing of this dedication appears to me to fit a new translation rather than a new edition of an old one. LOWNDES does not mention a 1609 edition, and I have not as yet met with one.

The 1624 and 1667 editions seem as inaccessible as that of 1609. It is, of course, possible that in many of the bibliographies Doctor HOLLAND's translation has been confused with Sir JOHN HARINGTON's : *The Englishman's Docter. Or, The Schoole of Salerne. Or, Physicall Obseruations for the perfect Preseruing of the Body of Man in continuall Health.* HARINGTON's translation, was first printed in 1607, and was reprinted, according to CROKE and LOWNDES (5) in 1609, 1617, and 1624. There seems no doubt that editions of both HOLLAND's and HARINGTON's translations appeared in 1617, but is that also true of the years 1609 and 1624? CROKE's bibliography of the English translations of the Schola Salernitana is confused on several points, and appears to be the source of later confusion.

Perhaps the reader can answer some of the questions posed

(5) LOWNDES says 1608, 1617, 1624. There were, in fact, editions printed in 1607, 1608, and 1609 (see *Short-Title Catalogue*).

here : Were editions of HOLLAND's translation of the *Regimen Sanitatis Salerni* actually published in 1609, 1624, and 1667 as well as in 1617, 1634, and 1649? Were there perhaps two editions or issues published in 1634, one " with Poetrie interspersed " and one without (that is, so far as the reading of the title-page was concerned)? Who was R. H., who signed the dedication of the 1634 edition, and IOSEPH FENTON, to whom " Anonymvs " dedicated the [first?] edition of 1617? These answers will prove not only of bibliographical interest, but also of biographical importance, since little is known of certain periods and phases of PHILEMON HOLLAND's career.

University of Virginia,
Charlottesville, Va., U.S.A. HERBERT SILVETTE.

Hartlib, Haak and Oldenburg : Intelligencers (1)

In these days of swift communication by newspaper, telegraph and radio, when every conceivable interest has its own publication or magazine devoted to its special concern, be it amateur photography or the teaching of mathematics, the difficulties of communication in the England of the Cromwellian and Restoration periods are hard to realize. But incidental references in contemporary account-books, letters and journals are illuminating to the twentieth century reader : the cost of a coach and four horses for the four days it took WILKINS and his friends to post the sixty miles or so from London to Oxford and return (2), the weeks that OLDENBURG had to wait for a package of books he wanted brought to him in London by some one travelling thither from Paris (3), the silence of nearly two years when Governor JOHN WINTHROP in Connecticut sent his letters to the Royal Society in London by ships that were lost (4), and the full two years it took MORAY's letter from London in 1665 to reach the governor in Hartford in 1667 (5).

Yet there was communication of news. The part that the coffee houses played as distributing centers is familiar to all students of the Restoration, and that important private individuals as well as the State frequently had a network of correspondents both in Europe and in the British Isles is also well known. How close the connections were between the virtuosi, the amateurs of

(1) A lecture read at Radcliffe College, Cambridge, Mass.. U.S.A. on November 2, 1938. Some of this material was gathered by the writer while a fellow on the John Simon Guggenheim Memorial Foundation.

(2) Guild Hall, London, MS. 2593/2 : *St. Lawrence Jewry : Churchwardens' Accounts*, 1640-1697, p. 385, for year 1661.

(3) *Works of Robert Boyle*, (6 vols. London, 1772), vol. VI, p. 150.

(4) *Ibid.*, vol. VI, pp. 156-157; " Correspondence of the Founders of the Royal Society with Governor WINTHROP of Connecticut between 1661-1672," *Proceedings of the Massachusetts Historical Society for* 1878 (Boston, 1879), p. 229.

(5) *Mass. Hist. Soc. Proceedings*, 1878, pp. 224-225.

science, in England and their fellow-workers on the continent has not been so clearly indicated. A study of these lines of communication illustrates many points : that work in science transcends all boundaries, both political and geographical, that intercourse and cooperation were widespread between English workers and those on the continent, that foreigners resident in England were a valuable contributing factor to this intercourse, and that one reason for the greatness of this century of genius in England was the encouragement and stimulus that came from similarly inquiring minds abroad.

Despite the increasing use of the vernacular languages,—English, French, Italian,—Latin was still the universal language of scholars,—a truism the significance of which can only be fully appreciated by the student today who wants to know what workers in other countries have written on a subject and finds that English, French and German are not enough. The virtuosi of the seventeenth century had this inestimable advantage of ability to read a common tongue, even though there was an increasing tendency for the English in particular to prefer to write their scholarly books in the language of their own people. BOYLE is the outstanding illustration of this tendency, for his books were written in English and had to be translated into Latin for European readers. GILBERT, HARVEY, NEWTON—the other foremost English scientists of the century,—all wrote their masterpieces in Latin.

With this advantage the channels of communication between the virtuosi in England and those on the continent were many. Englishmen travelled abroad on a grand tour with their tutors or followed their Oxford or Cambridge years with further study in foreign universities. Others followed exiled Royalists abroad for various reasons and travelled back and forth between London and Paris or the cities in the Low Countries where the Royalists clustered. Still others were sent abroad by the State to serve as resident sources of information for their home government. Similarly travellers came from France to the England of the Restoration, and other foreigners with Protestant connections found England more congenial than their home countries in time of persecution and war. Thus was woven a web of interlacing threads by which news of all sorts, political, military, social, and scientific could be passed along. For example, WILLIAM HARVEY

followed his training at Caius College, Cambridge, with four years' work at the University of Padua. WILLIAM PETTY at fifteen went to Normandy for several years to learn French, improve his Latin and Greek and study sciences. Not only did ROBERT BOYLE himself have six such study years in Europe, but his nephew, RICHARD JONES, had a similar training period in the late fifties with OLDENBURG as his tutor and companion. During the disturbances of the sixteen forties and fifties in England, courtiers like Sir KENELM DIGBY and Sir ROBERT MORAY went back and forth across the Channel repeatedly and others like Dr. JOHN PELL were resident on the continent for long periods of time as representatives of the government. Naturally these men while abroad mingled with others of like interests and wrote to their friends at home about these personal relationships as well as their business ones. We know that OLDENBURG went out of his way to call upon SPINOZA in Holland in 1661 and thus laid the foundation for a correspondence that lasted till OLDENBURG's death (6). Among the manuscripts in the British Museum (7) are a number of letters to Dr. JOHN PELL in Amsterdam, Breda and Zurich from his friend HAAK in London to whom, indeed, Dr. PELL owed his nomination first to his professorship in Amsterdam and later as representative of the Protectorate in Zurich (8). As the stirrings of the Thirty Years War became more serious in Europe, various Europeans crossed the Channel to England, some on visits, others ultimately to remain. From France had come PIERRE MOULIN to make two visits; his sons PETER and LOUIS came to stay, PETER to be a helpful translator of English science into French (9). Not long after the Pilgrim Fathers left Holland to escape the impending struggle between Spain and the Low Countries, two travellers from German-speaking lands crossed into England to be followed about fifteen years later by a third. These three men, HARTLIB, HAAK, and OLDENBURG, became the outstanding connecting links between the scientific activities of the amateurs in England and

(6) *The Correspondence of Spinoza*, translated and edited by A. WOLF, (New York, [1928?]), p. 35.

(7) Addit. MS. 24,850.

(8) AUBREY, JOHN, *Brief Lives, chiefly of contemporaries, as set down between 1669 and 1696*, edited by A. CLARK, (2 vols, Oxford, 1898) vol. II, p. 130.

(9) MASSON, DAVID, *Life of John Milton*, (7 vols., London, 1873). vol. V, pp. 215-224.

those on the continent. The ultimate result of the suggestion of one (10) was the formation of the Royal Society; the work of another was the founding in 1665 of the *Philosophical Transactions*, the oldest and the most important scientific journal in the English-speaking world.

MASSON in his monumental *Life of Milton* begins his account of SAMUEL HARTLIB, " the great Intelligencer " (11), with the remark " Everybody knew HARTLIB " (12). The son of a Polish merchant of German extraction, whose third wife, SAMUEL's mother, was the daughter of an English merchant in Danzig, SAMUEL HARTLIB was born about 1600 in Elbing in Prussia. He came to London shortly after 1628 and continued thereafter to make it his headquarters, doing business as a " merchant " and conducting an extensive foreign correspondence that amounted to a news agency. A public-spirited man with many and wide interests especially in education, he was commended by JOHN DURIE in 1635 as " a man very well known, beloved and trusted by all sides, a man exceeding painful, diligent, and cordially affected to these endeavors, and one that for such works had lost himself by too much charity." DURIE adds that he " is furnished with Polish, Dutch, English and Latin languages, perfectly honest and trusty, discreet and well versed in affairs " (13). HARTLIB wrote of himself late in life as " being familiarly acquainted with the best of Archbishops, Bishops, Earls, Viscounts, Barons, Knights, Esquires, Gentlemen, ministers, Professors of both universities, merchants, and all sorts of learned or in any kind useful men "(14).

HARTLIB's keen interest in education made him persuade COMENIUS, the Czech educational reformer, to visit England in 1641 in the hope that Parliament would take an interest in his pansophic schemes (15). It was to HARTLIB that MILTON dedicated his essay on education in 1644. HARTLIB's income of from

(10) *Record of the Royal Society* (3d edition, London, 1912), p. 4.

(11) *Mass. Hist. Soc. Proceedings*, 1878, p. 207.

(12) MASSON, *op. cit.*, vol. III, pp. 193-231.

(13) *Ibid.*, vol. III, p. 196.

(14) DIRCKS, HENRY, *A Biographical Memoir of Samuel Hartlib*, (London, 1865), p. 4.

(15) YOUNG, ROBERT FITZGIBBON, *Comenius in England* (Oxford, 1932) pp. 34-35. See also, STIMSON, DOROTHY, " Comenius and the Invisible College," *Isis*, no. 66 (vol. XXIII, 2), September 1935, pp. 373-388.

three to four hundred pounds a year was insufficient, he wrote, to cover all his aid to poor scholars and his various undertakings for education; and when by 1658, he fell on hard times, with his pension from Parliament unpaid and his fortune and his health gone, his friends had to come to his rescue with gifts of money. He died in obscurity in 1662 (17). In his petition to Parliament for aid HARTLIB summarized his usefulness to his fellowmen as being in three fields : " by erecting a little academy for the education of the gentry in piety, learning, morality and other exercises of industry not usual then in the common school, by helping godly ministers and scholars driven out from the Palatinate and other Protestant churches then laid waste, and by maintaining a foreign correspondence with a view to procuring learned tracts and accounts of inventions for publication, gaining relief for poor scholars, and obtaining constant intelligence in matters of piety, virtue and learning at home and abroad " (18). During his thirty years in England he was in constant correspondence with PETTY, WREN, BOYLE and other celebrities in science both on matters of state and general interest and on matters philosophical (19). From his correspondents in France, Ireland, Zurich, the Low Countries, New England, and Jamaica, from visits to him by foreigners from Poland and Germany, from his sons' travels abroad, as well as from friends like OLDENBURG abroad or in different parts of England, he assembled information and conveyed letters and packets of books for his friends among the virtuosi, as, for example, for BOYLE at Oxford or in the west of England (20). OLDENBURG wrote BOYLE from Saumur to address him in care of Mr. HARTLIB in London who will forward the letter to a friend in Geneva who will know where to reach him in Germany (21). Repeatedly in the letters of that age occur the phrases " through Mr. HARTLIB," or " in Mr. HARTLIB's care," or " Mr. HARTLIB knows "—truly a most useful man, an intelligencer in many fields.

Among HARTLIB's younger friends was THEODORE HAAK whom

(16) *Works of Boyle*, vol. VI, pp. 108, 125-126.

(17) TURNBULL, G. H., *Samuel Hartlib* (Oxford, 1920), p. 72.

(18) British Museum, Add. MS. 6269, fol. 29-31; see also KENNET, WHITE, *Register and Chronicle*, (London, 1728), vol. I, p. 872.

(19) DIRCK, *op. cit.*, p. 44.

(20) See HARTLIB's letters to BOYLE, *Works of Boyle*, vol. VI, pp. 76-136.

(21) *Ibid.*, vol. VI, p. 143.

COMENIUS names as one of the young men who in 1641 welcomed him at Dover to England (22). Born near Worms in 1605 of Calvinist parentage, HAAK first came to England in 1625 for a year at the universities. Then after three years in Europe he returned to Oxford where he was a commoner at Gloucester Hall for three years. He was admitted to the diaconate but never entered full orders. During the Cromwellian period he was employed by the Westminster Assembly of divines to translate into English the Dutch annotations on the Bible approved by the Synod of Dort, and was granted a Parliamentary pension therefor of 100 pounds a year (23). He also served as translator to Master Secretary THURLOE as the manuscripts in the Bodleian Library illustrate (24), and MASSON quotes two notes from the Council Order Books : Wednesday, June 26, 1650, " That the Declaration of Parliament be translated into Latin by Mr. MILTON, into Dutch by Mr. HAAK, and into French by Mons. AUGIER "; and on August 17, " That 50 pounds be paid by Mr. FROST to Mr. THEODORE HAAK and so much also to Mr. SAMUEL HARTLIB in regard of the many good services by them done by their correspondency in parts beyond the seas, and to enable them to continue it " (25).

As all who are familiar with the seventeenth century know, HAAK's chief fame lies in his having suggested the meetings out of which grew the Royal Society; for so Dr. WALLIS wrote January 29, 1696-7 " the first Ground and Foundation for the Royal Society was laid in London about 1645, if not before, at the suggestion of THEODORE HAAK a German of the Palatinate then resident in London " (26). Dr. HARCOURT BROWN in his study of the *Scientific Organizations in Seventeenth Century France* (1620-1680), has, I believe, been the first to point out HAAK's additional importance as an intermediary between French and English scientific thought twenty years and more before the Royal Society organized its committee for foreign correspondence. The proof of this con-

(22) YOUNG, *op. cit.*, p. 64.

(23) AUBREY, *op. cit.*, vol. I, p. 26; *Dictionary of National Biography*, " Theodore Haak."

(24) Rawlinson MS. A37, fol. 337.

(25) MASSON, *op. cit.*, vol. IV, pp. 228, 229.

(26) HEARNE, THOMAS, *Peter Langtoft's Chronicle*, (2 vols., Oxford, 1720) vol. I, pp. CXL, CLXII; STIMSON, DOROTHY, " Dr. Wilkins and the Royal Society," *Journal of Modern History*, vol. III, no. 4 (December, 1931), p. 545.

nection Dr. BROWN found in copies by HAAK in the British Museum of thirteen letters sent to him by Père MERSENNE in 1639-1640 and in five letters in Paris from HAAK to MERSENNE in 1647 and 1648 at the close of the Frenchman's life (27).

As analyzed by Dr. BROWN the first letter from MERSENNE in 1639 indicates a previous acquaintance, for MERSENNE knew that HAAK was friendly with COMENIUS and the mathematician JOHN PELL. Copies of this and other letters were kept by PELL also for they were crowded with important news of the scientific world on the continent; for example, on the work of ATHANASIUS KIRCHER in Rome on the magnet, and Father BENEDETTO's work on the same subject, of improvements in telescopes which made Venus appear as large as the moon, of the work of JEAN REY on the calcination of tin, and of the presence in Paris of a sensitive plant from the West Indies. MERSENNE was much interested in the agricultural writings of GABRIEL PLATTES which HAAK sent to him, and thought HAAK and PLATTES also should read the books of PALISSY the Potter, believing that both PLATTES and PALISSY, neither of them learned, and both proceeding on a basis of common sense would have come to the same conclusions in several matters (28). More than twenty years later OLDENBURG writing to BOYLE on October 13, 1664, an account of the session of the Royal Society held the preceding day, described a concert on an elaborate musical instrument, " an organ and five or six viols in one," invented by a Frenchman twenty one years ago and at that time reported on in England by Mr. HAAK. Further on in his letter he stated that MERSENNE gave the first notice of it (29).

Dr. BROWN enumerates some of the books sent to England by MERSENNE in the course of the correspondence, and then goes on to state as the most significant fact arising out of this correspondence that " one of the most important figures in the history of organized science in France is shown to be in close and friendly contact with a group of learned Londoners, through the medium of one who, according to the best authority, played a leading part in the establishment of the Invisible College, parent of the Royal Society. The letters do not permit us to say that MERSENNE

(27) BROWN, *op. cit.* (Baltimore, 1934), pp. 41-59.
(28) *Ibid.*, pp. 49-50.
(29) *Works of Boyle*, vol. VI, p. 159.

was an active influence in the establishment of the ' learned club ' which met in London in the years before the Commonwealth : we must merely note the fact that a close association with the amateurs of France and through them with the scientists of Italy appears to have been of mutual profit and advantage."(30)

Incidentally it is worth noting here that MERSENNE counted among his friends men who later were members of the Royal Society, as Sir KENELM DIGBY, the Duke of Newcastle, his brother Sir CHARLES CAVENDISH, and WILLIAM PETTY as well as JOHN PELL and HAAK,—illustrations again of the various means of communication between England and the continent (31). Thus HAAK, like HARTLIB, was an important intelligencer for the intellectuals in England and on the continent.

Even more useful was the third of this group, HENRY OLDENBURG, whose correspondence became so heavy and so important when he was made secretary to the Royal Society that later he printed a monthly account of the Society's affairs and of related matters in the now famous *Philosophical Transactions*. Born about 1615 near Bremen, OLDENBURG secured his education in that city. He first came to England in 1640, a dozen years after HARTLIB and HAAK had established themselves there, and after eight years returned to Europe and ultimately to Bremen. In 1653 that city sent him back to London as its agent to negotiate with CROMWELL, a mission that introduced him to MILTON, Latin secretary for the government. A year later he came again, and then decided to remain, at first serving as tutor to young lads, chief of whom was BOYLE's nephew RICHARD JONES. In 1656 he was at Oxford with his charge, and then for nearly four years in Europe with him. Upon his return to London in 1660 he joined the Royal Society in December while it was still in process of formation and soon thereafter he and WILKINS were named the first secretaries of the newly chartered Society. He and later HOOKE were the two fellows most devoted to its work, and the two who ultimately became its salaried officers, HOOKE as curator, OLDENBURG as secretary, to be joined some years later by a third, GREW, as curator of the repository. From 1660 till his death in 1677, OLDENBURG devoted himself to his work as intelligencer of scientific news and especi-

(30) *Op. cit.*, p. 56.
(31) *Ibid.*, pp. 36, 50.

ally after 1665 as editor of the *Philosophical Transactions* (32).

Though not a scientist, OLDENBURG was well equipped by education and by experience to be useful to his more distinguished friends. When he was first in London as agent for the Free City of Bremen, MILTON wrote him (July 6, 1654) : " You have indeed learnt to speak our language more accurately and fluently than any other foreigner I have ever known," and asked to be counted among his good friends (33). Later MILTON wrote him that his retirement was a loss to him, and to RICHARD JONES, MILTON wrote reminding him when studying abroad with OLDENBURG as his tutor to use his advantages fully, for " you have great advantages over others in this task, believe me, in having the aid of so faithful and experienced a guide " (34).

To BOYLE, his great friend and patron, OLDENBURG's services must have been well-nigh invaluable. Some years ago a student of mine made a classification of these services through an analysis of the correspondence between BOYLE and OLDENBURG (35) as it had been printed in the folio edition of BOYLE's writings edited by the Rev. THOMAS BIRCH in the eighteenth century. Supplementary material came from OLDENBURG's correspondence with SPINOZA recently edited by Professor WOLF of the University of London (36).

During the first years of the Restoration BOYLE lived in Oxford, in the west of England, or in Ireland, and not ofter or for long in London. Therefore OLDENBURG's service to him, we found, was as reporter on the occurrences in the scientific group in London and especially on what had happened at the weekly meetings of the Royal Society,—what experiments had been made, what books discussed, what notables had been present. From these meetings and also through his large correspondence abroad OLDENBURG was able in addition to convey to BOYLE news of European developments, and of the comings and goings of their friends across

(32) *Dictionary of National Biography*, " Henry Oldenburg "; MILTON, *Private Correspondence and Academic Exercises*, translated by P. B. TILLYARD (Cambridge, 1932), p. 28.

(33) MILTON, *op. cit.*, pp. 29, 30.

(34) *Ibid.*, pp. 36, 50.

(35) Unpublished paper in Goucher College Library by JANE R. MEADS on *Oldenburg's Usefulness to Boyle as Shown in Correspondence* 1657-1676 (March 1935).

(36) New York, [1928].

the Channel. Some of the news was political, but most of it was about people, books and experiments. In a letter of June 22, 1663, OLDENBURG told BOYLE of the admission of HUYGENS and of SORBIÈRE to membership in the Royal Society the preceding week and gave an account of the experiments with compression engines done at that session. Then he reported that he learned from his Paris correspondent that the king had given largesse to HUYGENS and to HEVELIUS. This Paris correspondent had also expressed great concern about BOYLE's health, for he commented, BOYLE is worth more than all the rest, and he recommended to him the virtues of the French climate. Finally OLDENBURG wrote that he could forward a package of books for BOYLE to Paris, if BOYLE wished, as he had a friend going shortly who would take it (37). In another letter written August 25, 1664, OLDENBURG, after reporting a delay in the receipt from Oxford of the Latin translation of BOYLE's book, and after retailing some items of foreign affairs, then summarized the meeting of the Royal Society of the day before,—that Dr. WALTER POPE's letter from Italy had been read with its account of terrible storms, that agreement had been reached to use the steeple of St. Paul's (this was before the Fire of course) for the experiment with the falling bodies, the Torricellian experiment and the vibration of a pendulum two hundred feet long. He added brief accounts of reports made about fire, water and earth damps in coal mines as extinguishing a torch and killing those who breathe it. Lastly he reported on the meeting at Mr. POVEY's of the recently appointed committee on correspondence for the Royal Society, forty strong but without Mr. BOYLE or his questions about Guinea, and that general enquiries had been drawn up—was this the first of the questionnaires?—serving all parts of the world, and that authors (books) had been distributed among the members to be perused for the collecting thence particular inquiries; then he added : " This was our entertainment above ground : I leave you to guess what our correspondence and entertainment was underground in the grotto, and near the well, that is, the conservatory of so many dozen of wine bottles of all kinds " (38). (A memorandum on this meeting in the archives of the Royal Society has the notation that " the

(37) *Works of Boyle*, vol. VI, pp. 147-148.

Committee never mett since Mr. POVEY's feasting of them "). (39).

But OLDENBURG was not merely a reporter of English and European scientific news; he served BOYLE as his literary agent in London, looking after the publication of his books, forwarding proof, attending to their translation into Latin by himself or by others, checking on the care with which the translation had been done, and finally heralding to his correspondents abroad the appearance of a new book by BOYLE and arranging for its shipment to the scientists in Europe. During the three years 1664-1667, according to this correspondence, OLDENBURG saw to the printing in English of BOYLE's *History of Cold*, the *Usefulness of Experimental Philosophy*, a second edition of the *Skeptical Chymist*, *Hydrostatical Paradoxes*, the *History of Colours*, *Thermometrical Experiments*, *Experiments of Light*, and a catalog of his works. He also translated into Latin five of these books (40).

With these labors went responsibility. He reported to BOYLE on November 5, 1664, that he had sent BOYLE's manuscripts to a printer who would " keep them unexposed to the eye of a philosophical robber " (41). And in an undated letter BOYLE wrote OLDENBURG that he was forwarding to him for his custody a mass of " notes and other loose papers " which were not to be shown to others in BOYLE's lifetime without his permission (42). BOYLE had difficulty with his eyes which in a measure disabled him and compelled him to use amanuenses, who were not always reliable, for BOYLE found that notes were unaccountably missing and some were surely stolen. For safety's sake, therefore, these papers were entrusted to OLDENBURG. There is no hint in these letters whether it was for honor and friendship alone or for pay, but clearly OLDENBURG served BOYLE wholeheartedly as reporter, as literary agent, as translator and as literaty guardian.

From this correspondence with BOYLE we learn also some of the details of OLDENBURG's personal life and of his activities in the service of the Royal Society as one of its two secretaries and as founder and editor of the journal, the *Philosophical Transactions*.

(38) *Ibid.*, vol. VI, pp. 149-151.
(39) Royal Society MSS.; *Miscellaneous : Papers of Councils, Committees, etc.*
(40) MEADS, *op. cit.*, pp. 12-13.
(41) *Works of Boyle*, vol. VI, p. 172.
(42) *Ibid.*, vol. VI, p. 38.

On November 5th, 1664, he wrote BOYLE that he had had an offer of a new correspondent in Paris who would send all the news and curiosities of France and Italy, and being a person of quality and philosophy would expect nothing in return but information about such considerable books as were continually printing in England, whether in English, Latin, Greek, etc., and some general account of the progress and performances of the Royal Society (43). His new correspondent, he reported on the 24th, had sent word of a design in France to publish from time to time a journal of " all what passeth in Europe in matters of knowledge both philosophical and political," and to include all books printed from 1664 on, and new editions, all experiences and new discoveries in arts and science, physics, astronomy, chemistry, medicine, etc., the names of those excelling in arts and science, what they had done and what they proposed, notices of deaths of important people with some account of their work, notices about the most notable academies and libraries, both public and private, any scientific questions and disputes, the most notable decisions of ecclesiastical and secular courts,—everything of interest to students. OLDENBURG said he was invited to contribute from England, to be paid in kind. He was already too busy, but remembered his motto, " Providebit Dominus,"—The Lord will provide (44). Thus OLDENBURG heralded to BOYLE the publication in January, 1665, of the *Journal des Sçavans*.

The first issue of his own monthly journal, the *Philosophical Transactions*, authorized by the Royal Society but written and published by OLDENBURG as his personal venture, did not appear until March, three months after the French *Journal*, thus losing by these three months the distinction of being the first scientific journal. Almost immediately, however, the *Transactions* became the model for the French *Journal* both in form and in emphasis on scientific matters, and extracts from the English monthly were frequent in the early issues of the *Journal* (45). In addition to the printing of scientific papers and news generally, an important function of this *Philosophical Transactions*, as OLDENBURG wrote

(43) *Ibid.*, vol. VI, p. 173.

(44) *Ibid.*, vol. VI, p. 179.

(45) MCCUTCHEON, ROGER P., " The *Journal des Sçavans* and the *Philosophical Transactions* of the Royal Society," *Studies in Philology*, vol. 21, 1924, pp. 626-628.

BOYLE late that August, was to register priority in discoveries. "I acknowledge," he wrote, "that that jealousy about the first authors of experiments which you speak of, is not groundless; and therefore offer myself to register all those you, or any person, shall please to communicate as new, with that fidelity, which both the honour of my relation to the Royal Society (which is highly concerned in such experiments) and my own inclinations, do strongly oblige me to" (46). Publishing the *Philosophical Transactions* was not an easy undertaking, however. In December he reported that only three hundred copies of the first *Transactions* had been sold and he feared that hardly enough would be sold to repay the charge of paper and printing, and therefore there would be no return to him (47). The difficulties of its proper distribution among the learned at home and abroad bothered him both then and later. The Plague of 1665 seemed peculiarly fatal to printers, increasing his difficulties (48), and the Oxford printer of three of the issues at this time paid him only nine pounds instead of the twenty pounds, ten shillings, he had expected to receive. With war beside and the printer's refusal to print a Latin version as well as the English one, poor OLDENBURG groaned to BOYLE that instead of the one hundred and fifty pounds a year he had expected to receive from the journal, his receipts would hardly amount to fifty pounds (49). Then after the Plague came the Fire of London in September, 1666. Soon after it, OLDENBURG wrote BOYLE two letters about the plans for surveying and rebuilding the city, and told of his own losses and difficulties. Those *Transactions* published but not sold had all been destroyed with the other books carried for safety into St. Faith's under St. Paul's. The City lay desolate. It would be hard to vend books now, and extraordinary expenses had increased. In the past ten days he had had to "pay twenty-four shillings to the public for chimnies, taxes and watching." There would probably be a drop in the receipts from the *Transactions* from the previously expected one hundred and fifty pounds to forty or even thirty pounds a year, since the printers wished to recoup their own losses in the Fire

(46) *Works of Boyle*, vol. VI, p. 193.
(47) *Ibid.*, vol. VI, p. 207.
(48) *Ibid.*, vol. VI, p. 209.
(49) *Ibid.*, vol. VI, p. 225.

through the sale of new issues with a smaller return to him. Moreover his wife's dowry of 400 pounds had already been exhausted. Therefore he asked BOYLE to secure for him some recognition of his services to the virtuosi, for the journal was not going to pay his house-rent, taxes and duties as he had hoped (50).

OLDENBURG pushed on with his correspondence and his publishing throughout that winter until the following June when he was cast into the Tower " for dangerous designs and practices." PEPYS wrote in his diary on June 25th, 1667, " I was told yesterday that Mr. OLDENBURG, our Secretary at Gresham College, is put into the Tower, for writing newes to a virtuoso in France, with whom he constantly corresponds in philosophical matters; which makes it very unsafe at this time to write, or almost do anything " (51). The other great diarist, JOHN EVELYN, also a fellow of the Royal Society, recorded on the 8th of August, that he had visited Mr. OLDENBURG " now close prisoner in the Tower, being suspected of writing intelligence," and added " I am confident he will prove an innocent person " (52). Such was the case. After his release on August 26th, OLDENBURG wrote BOYLE September 3rd : " I was so stifled by the prison air, that as soon as I had my enlargement from the Tower, I widened it and took it from London into the country to fan myself for some days in the good air of Craford in Kent. Being now returned and having recovered my stomach which I had in a manner quite lost I intend if God will to fall to my old trade if I have support to follow it. My late misfortune, I fear, will much prejudice me; many persons unacquainted with me, and hearing me to be a stranger, being apt to derive a suspicion upon me. Not a few came to the Tower merely to enquire after my crime, and to see the warrant; in which, when they found it was for dangerous designs and practices they spread it over London, and made others have no good opinion of me " (53). A week later he complained that he had had no letters except from BOYLE and Dr. BEALE " which makes me conjecture that foreigners especially

(50) *Ibid.*, vol. VI, pp. 228-230, 231.

(51) *Diary of Samuel Pepys*, edited by H. B. WHEATLEY (6 vols., London, 1926) vol. VI, p. 368.

(52) *Diary of John Evelyn*, edited by W. BRAY (2 vols., Everyman edition, London, 1920) vol. II, p. 29.

(53) *Works of Boyle*, vol. VI, pp. 237-238.

in the neighboring parts, may be grown shy to reassume that commerce they were wont to entertain with me, out of some tenderness and concern for my safety, which they may judge may be endangered as well by their freeness of writing to me as by mine of writing to them " (54).

He did not hesitate to stir up his correspondents, however, if one may judge by the letter he wrote that October to Governor WINTHROP of Connecticut. The Governor was one of the virtuosi and while in England the winter of 1660-1661 had been elected to the Royal Society. To him OLDENBURG wrote on October 13, 1667, to put him in mind of his being a member of the Royal Society though he was in New England, and that " even at so great a distance he might do that illustrious company great service." " Sir," he continued, " you will please to remember that we have taken to taske the whole Universe, and that we were obliged to doe so by the Nature of our Dessein. It will therefore be requisite that we purchase and entertain a Commerce in all parts of the World with the most philosophicall and curious persons to be found anywhere... If I am not much mistaken in the genius and cutt of the bulk of English Worthies, I see ground enough to presage that the Society will be fast rooted, grow and thrive to the wonder of others, the immortal fame of themselves, and the important benefit of this Island and whole Mankind." He concluded his letter with notice of the monthly issue of the *Transactions* " to inform the curious what passeth up and downe in the World in matter of Knowledge and Philosophy," and he urged Governor WINTHROP to " make it a good part of your business to recommend this reall experimental way of acquiring knowledge by conversing with, and searching into the works of God themselves; and that you will endeavor, and your ingenious and sober friends, to season and possess the youth of New England with the same " (55).

At length by the end of 1667 OLDENBURG wrote BOYLE, " I have no less at present, than 30 correspondents, partly domestick, partly foreign. Many of them I am not only to write to, but also to do business for, which requires much time to enquire after such particulars and dispatch such businesses as they desire, if I mean

(54) *Ibid.*, vol. VI, p. 238.
(55) *Mass. Hist. Soc. Proceedings*, 1878, pp. 229-230.

to be gratified reciprocally in such things as I bespeak of them. Besides my constant attendance on the meetings of the Society and Council and preserving what is said and done there, and giving order to have all registered and reviewing all the entries; soliciting also the performances of the manifold tasks recommended and undertaken by members of the Society; and distributing and sending abroad such directions and enquiries, as are thought conducive to our design, etc., I confess I extend my patience as far as I can; but I am afraid I have stretched it too far already that it will break, unless something be done to fortify it in some measure which I find not that any of those, who are upon the place, and cannot but see my daily labours and toil, are in the least solicitous of; though some of them are forced to acknowledge, even in my hearing, that no man in England would do what I do, upon the terms I go away with " (56).

The problem of finances continued to bother him. He had never received above forty pounds a year from the *Transactions* (and that was little more than his house rent) and the new agreement with the printers made the profit not more than thirty-six pounds a year (57). The renown of the Society, aided without question by his reports, increased his cares as a responsible officer of it. Restless under the pressure, he wrote, " I have served the Society gratis these six years and am a beggar to boot as to my private fortune " (58). But he kept at his work and on the last day of March, 1668, wrote BOYLE : " The fame of the Society riseth very high abroad, and makes strangers flock hither in troops; insomuch that since this March I have had no less than two dozen travellers addressed to me, whereof some make quick despatch, others stay longer." His second marriage in 1668 may have helped him financially for a time, but his bride brought him only eighty pounds. Finally his friends paid serious heed to his protests, and in 1669 the Society gave him a salary for his work as secretary. Though he held that post until his death in 1677, he had yet further to increase his income after 1670 by making Latin translations of books for others beside BOYLE (60).

(57) *Loc. cit.*
(58) *Ibid.*, p. 276.
(59) *Ibid.*, p. 279.
(60) *Dictionary of National Biography*, " Henry Oldenburg."

Throughout this period from March 6, 1665, until his death in 1677 OLDENBURG issued 136 numbers of the *Philosophical Transactions* and was himself the author or the translator of 34 of the articles in them. Papers read before the Society, letters, summaries and abstracts of books of special interest to the virtuosi,—the scientific news of the day was summed up in this journal. Published with the approbation of the Royal Society, yet the private concern of one of its officers, the journal even after OLDENBURG's death continued under private editorship through 46 volumes with only a certain amount of supervision from the President and Council of the Society. Finally in 1753 with the 47th volume the journal was taken over by the Royal Society and published by its Committee on Papers (61). Thus at length the intelligencers of the seventeenth century gave way to the editors of the eighteenth century. The undertaking OLDENBURG had fathered became such an important record of scientific progress during its long life that HUXLEY is reported to have said some sixty years ago that if all scientific literature were destroyed except the volumes of the *Philosophical Transactions*, the loss would not be irreparable for all discoveries and experiments of importance were reported in these volumes and most scientific contributions of worth were summarized therein (62).

Scientific achievement was not OLDENBURG's contribution to his age. Rather he was the friend and the correspondent of those who made the contributions, and though of too limited financial resources himself to be a patron and supporter of science, nonetheless he found his own niche as an intermediary for scientists and finally as founder and editor of the second oldest scientific journal, and the greatest in English. His career has an interesting parallel in that of a French contemporary of his, and one of his correspondents, JEAN CHAPELAIN (1595-1674) who was just such another friend of science and of scientists as OLDENBURG. His biographer claims that CHAPELAIN was one of the two men most responsible for the founding and editing of the *Journal des Sçavans*, and was one of the group consulted by COLBERT in 1665 on the organization of the Académie des Sciences the next

(61) *Record of the Royal Society*, p. 40.

(62) Was the *Philosophical Transactions* the earliest periodical publication in English in any field? I believe so.

year. The conclusion of this account of CHAPELAIN might stand also for the conclusion of OLDENBURG's life : " He took a small but active part in the scientific movement of his day, helping to found the institutions that were later to aid greater men. He was not a creator, not even an imitator. His only function was that of friend. There is no place for him among the great men of science, yet the historians of his time should not overlook his activity " (63).

So with HARTLIB, HAAK and OLDENBURG. Not creators or imitators themselves, their aid was indispensable to their friends at a time when science was fast passing from the hands of the virtuosi into those of scientists. The publication of NEWTON's *Principia* in 1687 marked the end of this classical period of modern science and the beginning of its true development. The intelligencers had done their work; they had provided the lines of communication between the virtuosi of Europe and those of England and among the English themselves. They had furnished the idea of cooperative friendly regular discussion that developed out of HAAK's proposal of the meetings of the " invisible college " in 1645 into the chartering of the Royal Society in 1662. They had built up a correspondence of such importance on matters scientific that OLDENBURG, the hardest working correspondent of them all, convinced of the need and value of a scientific journal to be issued regularly, himself undertook its publication. The great contribution of these men was to provide for individual scientists a hearing and recognition, the means of support and understanding, to give them the backing and encouragement of their fellow-workers and to spread the news of their achievements. Not even dabblers at it themselves, they truly loved science. HAAK and OLDENBURG particularly stand out among these amateurs of science as men without whose aid the seventeenth century advance in scientific achievement in England might well have been crippled.

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(63) GEORGE, ALBERT J. " A Seventeenth-Century Amateur of Science : Jean Chapelain," *Annals of Science*, vol. III, no. 2, (April, 1938), pp. 217-236.

Roemer and the first determination of the velocity of light (1676)

With facsimile reproductions (nos. XIX to XXI)

XIX " Demonstration touchant le mouvement de la lumiere trouvé par M. RÖMER " (*Journal des Scavans*, Dec. 7, 1676).

XX English translation of the above (*Philosophical Transactions*, June 25, 1677).

XIX Holograph manuscript of ROEMER's containing data on the eclipses of Jupiter's first satellite.

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1. The writing of this paper was originally undertaken to provide an introduction to the facsimile of the announcement of ROEMER's determination of the velocity of light. It was found by the present writer that there was in no one place a complete or satisfactory account of pre-ROEMER belief that the velocity of light was finite, and that almost all of the articles on ROEMER's work were written before the discovery of his notebooks and the manuscript reproduced here. Hence the length of this article.

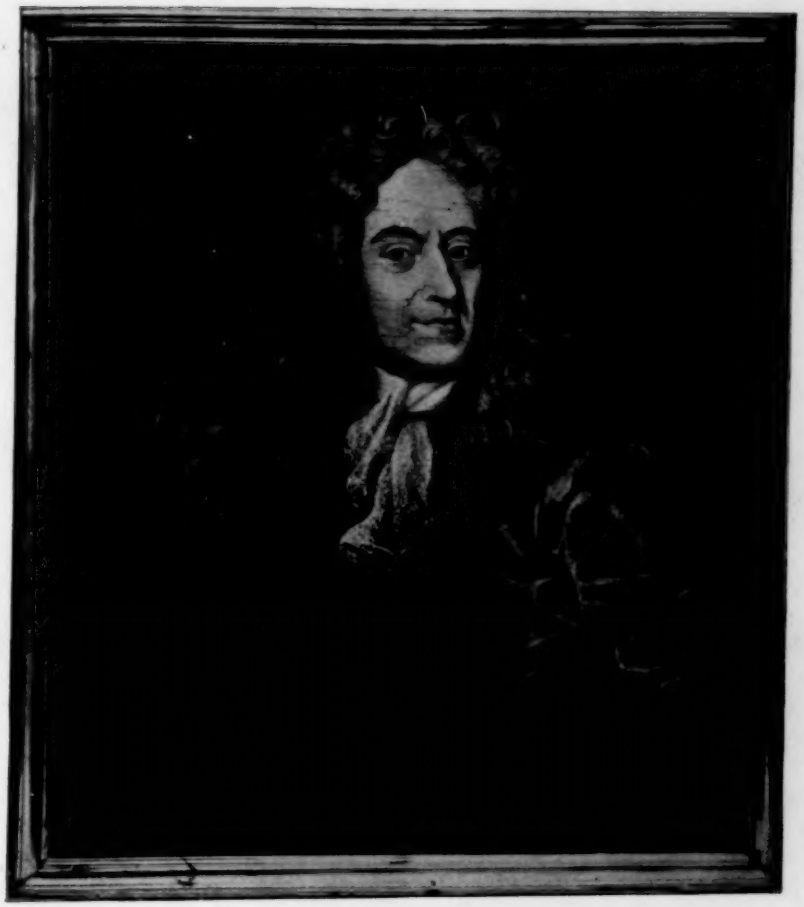
An exception must be made, of course, for the interesting articles by Dr. KIRSTINE MEYER (these chiefly in Danish periodicals) to which this paper is heavily indebted (See § 39). I should like to thank Dr. DANIEL NORMAN of the Harvard Observatory and Mr. HARRY LEVIN of the Harvard *Society of Fellows* for valuable criticism; also Miss JANE RUBY.

CHAPTER I

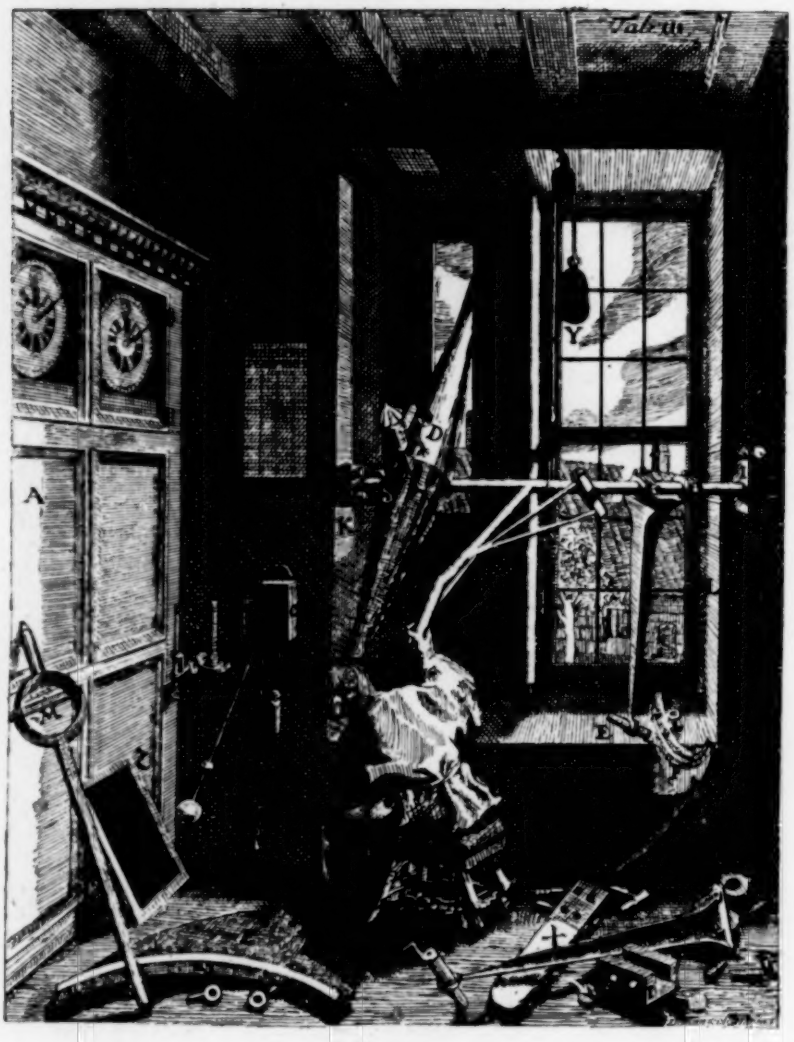
2. In September of 1676 OLE ROEMER (RØMER) announced to the members of the Paris *Académie des Sciences* that the eclipse of the innermost satellite of Jupiter, expected on the ninth of the following November, would occur exactly ten minutes later than the time computed on the basis of previous eclipses. He kept repeating this prediction, explaining that the delay would arise from the simple fact that astronomers considered light to be propagated instantaneously rather than " gradually ". When observation had confirmed his prediction, ROEMER told the members of the *Académie* that the speed of light was of such magnitude that it would require about 22 minutes to traverse the diameter of the annual orbit of the earth.

3. In order to appreciate fully the significance of ROEMER's work and to understand the quality of its reception, it is necessary to trace briefly the history of ideas concerning the finiteness of the velocity of light. It must, of course, he borne in mind that the lack of exact knowledge among early scientists concerning the nature and properties of light precluded any really significant statement by them about its velocity. Among the Greeks, for example, there seems to have been a general belief that this velocity was infinite. (This was not one of the more important problems : there was much more interest in catoptrics and problems such as whether vision proceded from the eye or the visible object). An exception to this general belief is EMPEDOCLES of Acragas (c.490-c.435 B.C.) the poet, philosopher, scientist and social reformer who, according to ARISTOTLE, " (and with him all others who used the same form of expression) was wrong in speaking of light as ' travelling ' or being at a given moment between the earth and its envelope, its movement being unobservable to us." (1) An interesting " proof " that the velocity of light must be infinite is given by HERON of Alexandria, famous for his steam engines as well as for his teleological explanation of reflection

(1) *The works of* ARISTOTLE (trans. into English under the ed. of W. D. ROSS), Vol. III, Oxford, 1931 : *De Anima*, p. 418*b*. For further criticism and discussion of EMPEDOCLES by ARISTOTLE, see, in the same volume, *De Sensu*, pp. 446*a*-447*b*.



OLE ROEMER (1644-1710)
see § 40.



ROEMER's transit instrument [from HORREBOW's *Basis*, etc. (Ch. VIII)]
see §§ 34, 35.

by means of a minimum path. According to HERON, you turn your head to the heavens at night, keeping the eyes closed; then suddenly open them, at which time you see the stars. Since no sensible time elapses between the instant of opening the eyes and the instant of sight of the stars, light (or vision : HERO believed vision to be due to an emanation from the eye) must travel instantaneously (2).

4. Among the Islamic scientists, AVICENNA [ABÛ 'ALÎ AL-ḤUSAIN IBN 'ABDALLÂH IBN SÎNÂ] (980-1073) was perhaps the most famous : his thought, it is said frequently, represents the climax of medieval philosophy. AVICENNA made a study of many physical questions and observed that if the perception of light is due to the emission of some sort of particles by the luminous source (as he believed) then the speed of light must be finite (3). ALHAZEN [ABÛ 'ALÎ AL-ḤASAN IBN AL-ḤASAN IBN AL-HAITHAM] (c.965-c.1039), another Muslim physicist and one of the greatest students of optics of all time, discovered the explanation of twilight, of the apparent increase in size of the sun and the moon when near the horizon, and of binocular vision. In his treatise on optics (4) he states that light is a movement and, as such, is at one instant in one place and at another instant in another place. Since it is not in both of these places at the same time, there must be a lapse of time between the two : hence the transmission cannot be instantaneous—" Lux et color ex sese, percipiuntur in tempore." (5)

(2) HERON : *Catoptrique* in *Heronis Alexandrini Opera quae supersunt omnia* (ed. by L. NIX and W. SCHMIDT), Vol. II, part 1, Leipzig, 1900, p. 322.

Many writers, following the example of HOPPE, state incorrectly that HERON believed light to have a finite velocity.

(3) GEORGE SARTON : *Introduction to the History of Science*, Vol. I, Baltimore, 1927, pp. 709-12.

(4) *Opticae Thesaurus*, book II, chapter II, article 21. In RISNER's edition, *Alhazeni Arabis libri septem, nunc primùm editi. Ejusdem liber de crepusculis et nubium ascensionibus. Item Vitellionis Thuringopoloni libri X. Omnes instaurati, figuris illustrati et aucti, adjectis etiam in Alhazenum commentariis, a* FEDERICO RISNERO, Basel, 1572, pp. 37-8.

(5) For a discussion of optical theories of this period see JOSEPH PRIESTLEY : *History and Present State of Discoveries relating to Vision, Light, and Colours*. London, 1772. See also F. M. SHUJA : *Cause of refraction as explained by the Moslem scientists*. (Read at the second session of the Idara-i-ma'arif-i-Islamiya, Lahore, April 1936.) Privately printed, Jamia Press, Delhi.

5. It is curious to note that ROGER BACON (c.1214-1292) although in perfect agreement with ALHAZEN's conclusions on this subject, felt that he must show, nevertheless, that they were arrived at on no proper basis. BACON was interested in astrology (in which he believed implicitly) and was interested in the means whereby the astral influences, as well as starlight, were transmitted through space. In his *Opus Majus* (6) he says that " all authorities make this statement [that light travels instantaneously] except ALHAZEN who attempts to prove this view false... But these reasons of ALHAZEN do not have any weight." Essentially, BACON shows that the sort of reasoning used by ALHAZEN is identical with that of the scientists who attempt to prove the opposite view. Yet BACON merely replaces ALHAZEN's metaphysical argument by his own, equally metaphysical (7), to conclude that

> ARISTOTLE's statement that there is a difference between the transmission of light and that of other sensory impressions... is not to be understood as consisting in the fact that light is transmitted instantaneously and the other impressions require time... this difference is not one of instantaneousness and time, but of less time and more time (8).

6. Roger's namesake, FRANCIS BACON (1561-1626), seems to have felt, rather than to have really believed, that the velocity of light was finite. His remarks on the subject afford a striking example of the confusion exhibited by a first rate mind attempting to be reasonable with no genuine scientific or experimental basis as guide. Discussing motion, he says that (9)

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(6) GUY DE FOULQUES, who was Pope CLEMENT IV 1265-1268, sent a letter to BACON in 1266 asking for copies of all his writings. Stimulated by this interest, he composed the *Opus Majus*, *Opus Minus*, and *Opus Tertium*, giving a complete exposition of his doctrines. These he sent to Rome in 1268, but CLEMENT died a few months later and it is not known whether or not they were received. For all its importance, the *Opus Majus* remained unpublished until given an incomplete edition by SAMUEL JEBB in 1733. (*Isis*, Vol. XI, 1928, pp. 138-41).

(7) ROGER BACON : *Opus Majus* (trans. into English by ROBERT BELL BURKE), Philadelphia, 1928; Part V (concerning optics—in three sections) section I, ninth distinction, Chapters II and III.

(8) A particular problem that bothered BACON was that of the " multiplication " of light for which see *op. cit.*

(9) FRANCIS BACON : *Nouum organum, siue indicia vera de interpretatione naturae* London, 1620; or *Philosophical works of* FRANCIS BACON (ed. from the edition

Even in sight, whereof the action is most rapid, it appears that there are required certain moments of time for its accomplishment... [It is not surprising that we do not see the actual passage of light, for there are] things which by reason of the velocity of their motion cannot be seen—as when a ball is discharged from a musket... This fact, with others like it, has at times suggested to me a strange doubt, viz. whether the face of a clear and starlight sky be seen at the instant at which it really exists, and not a little later; and whether or not, as regards our sight of heavenly bodies, [there is] a real time and an apparent time, just like the real place and apparent place which is taken account of by astronomers in the correction for parallaxes... [whether or not] the images or rays of heavenly bodies... take a perceptible time in travelling to us. But this suspicion as to any considerable interval between the real time and the apparent afterwards vanished entirely... what had most weight of all with me was, that if any perceptible interval of time were interposed between the reality and the sight, it would follow that the images would oftentimes be intercepted and confused by clouds rising in the meanwhile, and similar disturbances of the medium (10).

In direct contrast to this, the attitude of JOHANN KEPLER (1571-1630) represents a complete reversion to ARISTOTLE. KEPLER wrote two treatises on optics; one concerned entirely with refraction (11) and the other, an earlier work, a sort of commentary and supplement to VITELLIUS (12), a treatise on the whole science of light. In this earlier work (13) he maintains that light can be propagated into illimitable space; requiring no time, since, being immaterial, it can offer no resistance to the moving force. According to Aristotelian mechanics, this gives to light an infinite velocity.

7. In the face of all this, the remarks of GALILEO (1564-1642) seem like a breath of fresh air in a stale room. In his great

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of ELLIS and SPEDDING by J. M. ROBERTSON) London, 1905, p. 363 (Aphorism XLVI of the " second book of aphorisms concerning the interpretation of nature and the kingdom of man ").

(10) The final part of this quotation is curious, for are not the " images " of stars actually " intercepted... by clouds "?

(11) JOHANN KEPLER : *Dioptrice*, Augsburg, 1611.

(12) VITELLIUS (WITELO, VITELLIO, or VITELO) was a Polish physicist and philosopher, whose main work was a treatise on optics taken largely from ALHAZEN, ARISTOTLE, EUCLID and PTOLEMY. His importance lies largely in being a main link in the chain of transmission of Graeco-Arabic optics. His treatise, VITELLIONIS *mathematici doctissimi περὶ ὀπτικῆς, id est de natura, ratione et protectione radiourum visus, luminum, colorum, atque formarum, quam vulgo perspectiuam vocant libri* X was published in Nuremburg in 1535. The third edition, ed. by F. RISNER, was appended to RISNER's Latin edition of ALHAZEN. (See note 5.)

(13) JOHANN KEPLER : *Ad Vitellionem paralipomena quibus astronomiae pars optica traditur*, Frankfurt, 1604.

treatise on mechanics (14) there is, in the " dialogue of the first day," a conversation about the velocity of light. In the course of this conversation, *Salviati* says that the general inconclusiveness of observations on this subject had led him to an experiment by which the question of whether or not light had a finite velocity might actually be settled. He says :

> Let each of two persons take a light contained in a lantern, or other receptacle, such that by the interposition of the hand, the one can shut off or admit the light to the vision of the other. Next let them stand opposite each other at a distance of a few cubits and practice until they acquire such skill in uncovering and occulting their lights that the instant one sees the light of his companion he will uncover his own (15).

After acquiring this skill, the two experimenters were to perform the same operations at greater distances, ten miles if necessary (using telescopes).

> If the exposures and occultations occur in the same manner as at short distances... we may safely conclude that the propagation is instantaneous; but if time is required at a distance of three miles, which, considering the going of one light and the coming of the other, really amounts to six, then the delay ought to be easily observable (16).

This experiment was executed by the Florentine Academy (17) and their account of it is as follows (18) :

> GALILEO in the first Dialogue of his *Treatise* of *Two New Sciences*; suggests an easie way to discover, whether *Light* moves in time, or with an *Instantaneous*

(14) GALILEO GALILEI : *Discorsi e dimostrazioni matematiche intorno à due nuoue scienze attenenti alla mecanica & i movimenti locali, del Signor* GALILEO GALILEI *Linceo, filosofo e matematico primario del serenissimo Grand Duca di Toscana con vna appendice del centro di grauità d'alcuni solidi*, Leyden, 1638.

(15) English trans. of *Discorsi etc.* by H. CREW and A. DE SALVIO, New York, 1914, p. 43.

(16) GALILEO, of course, had no idea how large this finite velocity might be. Since light travels at about 186,000 miles/second, it would traverse six miles in about 0.000 03 seconds and the experiment could give no results.

(17) The *Accademia del Cimento* of Florence was one of the very first organized scientific societies and flourished for ten years (1657-1667), supported by the brothers MEDICI, Grand Duke FERDINAND II and LEOPOLD (both of whom, in addition to displaying interest as patrons, actually performed experiments).

(18) The work of this academy was published as *Saggi di Naturali Esperienze fatte nell' Accademia del Cimento*, Florence, 1667. We quote from the translation, *Essayes of Natural Experiments made in the Academie del Cimento*, Englished by RICHARD WALLER, London, 1684, p. 157. Or, see PIETER VAN MUSSCHENBROEK : *Tentamina experimentorum naturalium captorum in Accademia del Cimento*, Leipzig, 1730.

Velocity : the Trial consists in the *Confederacy* of Two Companies of Men to expose Two *Lights* to each others *view*, so that the discovery of the one, may answer immediately to that of the other : that when the one uncover their *Light*, and expose it, they may at the same time perceive the *Light* of their *Confederates*. This being often practised at a small distance GALILEO desired to have the same tryed by observers at a greater Distance; to see, if the mutual *Correspondence* of Exposing and Covering their *Lights*, kept the same Measure as when nearer; that is, without any observable *Delay*.

We tryed it at a Miles distance (which in the going forward, and Return of the *Light* must be reckon'd Two, and could not observe any. If in a greater *Distance* it be possible to perceive any sensible *Delay*, we have not yet had an opportunity to try (19).

8. We come at last to DESCARTES (1596-1650) whose adherence to the idea of instantaneous propagation set up a major obstacle to the acceptance of ROEMER's work. Much light is thrown upon DESCARTES' views by an examination of his relationship with BEECKMAN (20) and of the latter's work. BEECKMAN seems to have been certain, not only that the velocity of light was finite, but that this fact could be verified experimentally and the magnitude of that velocity determined. In his journal, under the date March 19, 1629, we find the following entry confirming this :

Distet homo ab alio per tot miliaria per quod (*lege* quot) bombardi explosi lumen potest videri; & quo spatium hoc fit majus, stet uterque in monte excelso, ne quid in medio obstet quo minùs lux vel flamma ignis accensi videri possit. Versimile autem est, magnum spatium requiri ad differentiam aliquam notandam tempore, ob incredibilem luminis in movendo celeritatem. Uterque homo habeat exactissimum horologium portatile, & uterque, tam is qui bombardo exploso astat quàm qui tam longe ab eo remotus est, uterque, inquam, eo momento quo lumen videt, in horologij celerrimâ rotâ notet punctum aliquod, vel atramento vel alio modo, quo exacte potest scire quot denticuli tacti fuerint dum sibi invicem in viâ occurrerunt. Uterque enim cum horologio suo ad socium proficiscatur; atque ubi sibi occurrerint, unusquisque numeret quot denticuli in suo horologio transierint;

(19) After *Salviati* concludes his description of the experiment (in the *Discorsi*), he attempts to prove that light takes time in propagation as follows. In a lightning flash between clouds eight or ten miles away, we see the light located at a particular point, and then notice it spread to the surrounding area. If the propagation were instantaneous, we should not be able to distinguish between the initial center of the lightning and the later outlying portions.

(20) ISAAC BEECKMAN (1570-1637), a Dutch physicist, author of *Mathematico-physicarum Meditationum, Quaestionum, Solutionum Centuria*, Utrecht, 1644, appears to have been interested in almost every important physical question of the seventeenth century. He published practically nothing during his lifetime and was known almost entirely through his correspondence. His journal was discovered at the turn of the last century, but as yet it has not been edited and published.

idque saepiùs fiat, permutatis horologijs. Versimile mihi videtur, non tantam esse lucis celeritatem, quin illi deprehensuri sint, plures dentes transijsse in horologio ejus qui bombardo exploso adstiterat (21).

A letter from DESCARTES to BEECKMAN, dated August 22, 1634, is of particular interest (22). BEECKMAN had tried to convince DESCARTES that the velocity of light was finite, but without much success. DESCARTES, in defense of his belief in instantaneous propagation, had worked out what seemed to him to be final and complete proof that his belief was the only one tenable. But before presenting this proof to his correspondent, he reviews all of their previous correspondence and interchange of ideas on the subject. (The review is of special interest as most of the previous letters seem to have been lost.) He mentions several of BEECKMAN's experiments that had failed (23), saying " addique etiam hoc mihi esse tam certum " that light travelled instantaneously " vt si falsitatis argui posset, nil me prorsus scire in Philosophia confiteri paratus sim " and also, " si quae talis mora sensu perciperetur, totam meam Philosophiam funditus euersam fore inquiebam." DESCARTES' argument in favor of instantaneous propagation is, in principle, scientifically sound as opposed to unconfirmed hunches (GALILEO) and metaphysical arguments (BACON, ALHAZEN) such as have just been described. The mistake he made was in the estimation of how large the velocity of light might be if it were finite : his value being much too small.

He considers an eclipse of the moon, caused by the moon, earth, and sun being in a straight line, with the earth interposed between the other two. Now suppose that it requires an hour, say, for light to travel from the earth to the moon. Then the moon will not become dark until exactly one hour after

(21) This is quoted in the edition of the *Œuvres de* DESCARTES edited by C. ADAM and P. TANNERY, Paris 1897-1910, Vol. X, p. 552. It is there said to have come from BEECKMAN's journal, fol. 340, verso, lines 22-42. In what follows, references to the above edition of DESCARTES will be made as " *Œuvres* (A-T) Vol. X ", etc.

(22) *Œuvres* (A-T) Vol. II, Letter LVII. See note 119.

(23) The latest experiment of BEECKMAN's described by DESCARTES is a very simple qualitative one. A mirror was to be placed as far away as possible within the range of vision. Then a torch was to be waved from side to side at night. If the sight, in the mirror, of the torch's motion (or change of motion) preceded the actual motion (or change of motion) of the hand, light would travel with a finite velocity.

the instant of collinearity of the three bodies. Similarly, we, here on the earth, will not observe the moon's darkening until the passage of another hour, or until two hours after the moment of collinearity. But in this time, the moon will have moved in its orbit and the three bodies will no longer be collinear. But clearly, argues DESCARTES, this is contrary to experience, for one always observes the eclipsed moon at the point of the ecliptic opposite to the sun (so that, for example, one never sees the sun and the eclipsed moon simultaneously) (24). Hence light does not " travel in time," but in an instant (25).

9. With this observation as basis, DESCARTES asserts in his two works on optics, that light travels instantaneously. Yet, in neither

(24) CHRISTIAAN HUYGENS, in the first chapter of his *Traité de la Lumiere, Où sont expliquées les causes de ce qui luy arrive dans la Reflexion, & dans la Refraction. Et particulierement dans l'etrange Refraction du Cristal d'Islande. Par* C. H. D. Z. *Avec un Dicours de la Cause de la Pesanteur*, Leyden, 1690 (pp. 4-6) discusses the ideas of DESCARTES about the velocity of light, before he gives ROEMER's demonstration that this velocity is finite and of such magnitude that it takes light 11 minutes to come from the sun to the Earth. (The *Traité de la Lumiere* was written by HUYGENS during his sojourn in France and was communicated to the Paris *Académie Royale des Sciences* in 1678.) HUYGENS knew of this astronomical " proof " since the letter to BEECKMAN mentioned above was included in all of the DESCARTES' letters, of which there were several during the seventeenth century. (In none of these, however, is BEECKMAN's name mentioned : no addressee is given). HUYGENS shows that if it would take light one hour to go from the Earth to the moon the retardation of the sight of the eclipsed moon would be sensible, but if it took but ten seconds to traverse this distance such would no longer be the case. Further, making use of the data he had computed in his treatise on Saturn (that the radius of the Earth's orbit is about twelve thousand diameters of the Earth, and hence four hundred times greater than the distance from the Earth to the moon) and of ROEMER's figure, he concludes that it takes light only 11/400 minutes or about 1.5 seconds to get from the moon to the Earth, removing whatever validity DESCARTES' argument might have had. On this point cf. § 10.

(25) In Vol. VIII of the *Œuvres complètes* de CHRISTIAAN HUYGENS, published by the *Société Hollandaise des Sciences*, the Hague, 1888-1937 (which we shall refer to hereafter as " *Œuvres* (S.H.) Vol. VIII " etc.) there is a set of correspondence between ROEMER and HUYGENS, in which HUYGENS explains to ROEMER why DESCARTES' argument falls through. ROEMER had not read the letter of DESCARTES to BEECKMAN referred to above and so was, at first, puzzled by the reference. In *Œuvres* (S.H.) Vol. XIX, pp. 432-35 there is an interesting paper of HUYGENS in which he elaborates the material mentioned in the previous note. It is entitled *Calcul d'une limite inférieure de la vitesse de la lumière dans l'espace d'après les observations des éclipses de la lune, et démonstration d'un théorème de Roemer sur ces éclipses* (1677).

of these does he give this basis for his assertion (26), but prefers to reason analogically using in one instance, a blind man who feels the impact of his stick upon a stone the moment the stone is struck, and in the other, a pile of elastic balls, where a movement of one of the balls at the bottom of the pile is transmitted instantaneously to those at the top. DESCARTES is perfectly willing to admit that the concept of instantaneous transmission is difficult to grasp (27). MERSENNE questioned him on this point, being bothered by the seeming exclusion of priority of place (i.e., if light travels instantaneously, how can it be first in one place and then in another, for that would imply a lapse of time between the instants of being in the two places) (28). DESCARTES replied only "pour la difficulté que vous trouvez en ce qu'elle se communique en vn instant, il y a de l'équiuoque au mot d'instant... " (29).

In the second chapter of the *Dioptrique*, DESCARTES gives a proof of the Law of Sines (correct law of refraction) by considering

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(26) That the reasoning from the eclipses of the moon actually was his basis is shown by a letter of his to MERSENNE of October 11, 1638 (*Œuvres* (A-T) Vol. II, Letter CXLVI) which is a *compte rendue* of GALILEO's *Discorsi... à due nuoue scienze*, which had just appeared (see Note 14.). He says of the experiment devised by GALILEO (See § 7) that " Son experience, pour sçauoir si la lumiere se transmet en vn instant, est inutile car les Ecclipses de la lune se rapportant assez exactement au calcul qu'on se fait, le prouuent incomparablement mieux que tout ce qu'on sçauroit esprouuer sur terre."

Note that this letter postdates the *Dioptrique* by a year.

(27) In the first of the two optical treatises, the *Dioptrique—Discours de la methode pour bien conduire sa raison, & chercher la verité dans les sciences : plus la Dioptrique, les Meteores, et la Geometrie ; qui sont des essais de cette methode*, Leyden, 1637, or *Œuvres* (A-T) Vol. VI—he says (*Discours Premier : de la Lumiere*) that

> Ce qui vous empeschera d'abord de trouuer estrange, que cette lumiere puisse estendre ses rayons en vn instant, depuis le soleil iusques a nous : car vous sçaués que l'action, dont on meut l'vn des bouts d'vn baston, doit ainsi passer en vn instant iusques a l'autre, & qu'elle y deuroit passer en mesme sorte, encores qu'il y auroit plus de distance qu'il n'y en a, depuis la terre iusques aux cieux.

In the later work—*Le Monde de Mr.* DESCARTES, *ou le Traite de la Lumiere, & des autres principaux objets des sens : auec un Discours du Mouuement Local, & un autre des Fieures, composez selon les principes du même Auteur*, Paris, 1664, or *Œuvres* (A-T) Vol. XI,—(Chapter XII : *Des proprietez de la Lumiere*) there are listed twelve chief properties of light, of which the third is the instantaneity of its transmission. This is supported by the analogical argument of the balls.

(28) Cf. ALHAZEN, § 4.

(29) *Œuvres* (A-T) Vol. II, letter CXXIII.

a ball which is struck by a racket and then goes through the air to strike another medium, say water. By taking components of the velocity of the ball, he derives the proper relation between the angle of incidence and the angle of refraction. An erroneous conclusion therefrom is that light travels faster in a denser medium than in one less dense : this being arrived at analogically, from the example of the balls, as also the Law of Sines for the motion of light. For a seventeenth century philosopher, it was a simple matter to argue from a finite case to an infinite case and *vice versa;* so that from the finite velocity of the ball, DESCARTES could get to the case of the infinite velocity of light with no difficulty. But what is really curious is the conclusion, however erroneous, that light travels faster in the denser medium. For, if light were supposed to have an infinite velocity, it is not at all clear what such a statement would mean (30).

10. We conclude this chapter with ROBERT HOOKE (1635-1703) who groped at the idea of a wave theory of light. He has some rather pertinent remarks to make in his *Micrographia* (31) where, after a very general discussion of the nature of light and refraction, in which he says that light is essentially a motion that is " exceeding quick," he adds that light

> may be communicated or propagated ... to the greatest imaginable distance in the least imaginable time; though I see no reason to affirm that it must be in an instant : For I know not any one Experiment or observation that does prove it... [And as for most statements on the subject,] I have this to answer, That I can as easily deny as they affirm... If indeed the propagation were very slow, 'tis possible something might be discovered by Eclypses of the Moon; but though we should grant the progress of the light from the Earth to the Moon, and from the Moon back to the Earth again to be full two minutes in performing, I know not any possible means to discover it; nay, there may be some instances perhaps of Horizontal Eclypses that may seem very much to favour this supposition of the slower progression of Light than most imagine. And the like may be said of the Eclypses of the Sun, &c."

(30) In an article in the *Bulletin de la classe des Sciences (Académie Royale de Belgique)* Vol. XXIII, 1937, pp. 689-92, entitled " La vitesse de propagation de la lumière selon DESCARTES," TH. DE DONDER and J. PELSENEER show that DESCARTES considered light in two distinct ways : as a transportation of energy and as a field in an incompressible aether, one implying a finite velocity, the other an infinite velocity.

(31) ROBERT HOOKE : *Micrographia : or some Physiological Descriptions made by magnifying glasses. With Observations and Inquiries thereupon,* London, 1665, p. 56.

CHAPTER II

11. The *Académie Royale des Sciences* was founded in 1666 by LOUIS XIV, on the advice, largely, of COLBERT, his finance minister.

COLBERT était doué d'un génie trop pénétrant pour ne pas diviner l'avenir réservé aux sciences; il pressentit les applications que leur devraient un jour les arts et l'industrie; il mesura d'un coup d'œil l'importance pratique de recherches qui n'avaient guère encore de son temps qu'un caractère spéculatif. LOUIS XIV approuva son projet et l'Académie des sciences fut fondée (32).

One of the first projects of the *Académie* (directly in line with its practical aims) was the preparation of maps less defective than those in use at the time (33). Such a project was feasible, as the pendulum clock invented by HUYGENS in 1657 was reliable enough to serve in the determination of longitudes (34). What was needed was an astronomical phenomenon, capable of simultaneous observation from a place of known longitude and the place whose longitude was to be determined. In addition, of course, such a phenomenon would have to lend itself to fairly frequent observation in order to be really serviceable. That such was to be found in the eclipses of the satellites of Jupiter was manifest to GALILEO, who had discovered the first four satellites in January of 1610 (35). But before they could be used for this purpose, tables of their motion were needed (36). The earliest tables

(32) L.-F. ALFRED MAURY : *L'ancienne Académie des sciences*, Paris, 1864.

(33) These maps were particularly defective in longitudes and East-West distances. In ROEMER's *Adversaria* (See Note 113) there are many references to such errors.

(34) That HUYGENS has this particular use in view when he invented his pendulum clock may be seen in a letter of his dated February 1, 1657 : " j'espère bien d'appliquer [mon invention] avec succes a la recherche des longitudes ", *Œuvres* (S.H.) Vol. II Letter 370.

(35) ROBERT GRANT : *History of Physical Astronomy*, London, 1852, Chapter VII.

(36) According to GRANT (*op. cit.*, pp. 79-80) GALILEO never was able to realize his plan for using these satellites for such purpose since he never completed tables of their motion. He announced from time to time that he was preparing such, but after his death, his efforts seem not to have been preserved. SIMON MAYER, the German astronomer who claimed to have discovered the satellites independently of GALILEO, made tables of their motions in order to bolster up his claim. GIOVANNI BATTISTA HODIERNA (1579-1660), a Sicilian astronomer, published his

of this sort that enjoyed any confidence at all among astronomers were those published by GIOVANNI DOMENICO CASSINI in 1668 (37). In the introduction to a later set of tables (38) CASSINI says that

> Avant mon départ de Bologne au mois de Mars 1668. je m'étois pressé de publier mes premieres Tables du mouvement des Satellites de Jupiter... Elles n'étoient pas si exactes que celles que je continuai de faire... mais je jugeai qu'il ne falloit pas differer de les donner au Public toutes imparfaites qu'elles étoient, ... afin que les Astronomes qui n'en avoient pas d'autres qui pussent servir à cette usage... eussent la commodité d'observer de concert les configurations & les Eclipses de ces Satellites, pour les faire servir à l'invention des longitudes : ce qui a eu l'effet que j'en avois esperé, ces Tables & ces Ephémerides n'ayant pas plûtôt paru que les Astronomes de diverses Nations s'en servirent pour observer de concert ces Satellites, & pour tirer du rapport de ces Observations la difference des longitudes des lieux éloignez où elles ont été faites (39).

The method, then, adopted by the *Académie* was the simultaneous observation of the eclipses of the satellites of Jupiter, at Paris and at the place where the longitude was to be determined. However, it should be noted that the first observations of these eclipses that were made at Paris were those of JEAN PICARD (1620-1682) and were (40) undertaken before CASSINI (1625-1712)

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incomplete observations of the satellites in 1656, together with a theory of their motion. A year later GIOVANNI ALFONSO BORELLI (1608-1679) attempted to work out a better theory, based on his and HODIERNA's observations.

(37) GIOVANNI DOMENICO CASSINI : *Ephemerides Bononienses Mediceorum Syderum ex Hypothesibus & Tabulis* Bologna 1668.

(38) *Les Hypotheses et les Tables des Satellites de Jupiter, Reformées sur de Nouvelles Observations*, Paris, 1693; reprinted in *Anc. Mém.*, Vol. VIII.

There were published in 1730 eleven volumes : *Recueil des Mémoires de l'Académie Royale des Sciences depuis 1666 jusqu'a 1699*. In the first volume, there is an advertisement which says that the first two volumes (these are historical : Vol. I 1666-1686, Vol. II 1686-1699) were written by BERNARD LE BOVIER DE FONTENELLE (1657-1757), who became *secrétaire perpétuel* of the *Académie* in 1699, and based on DU HAMEL's Latin history (See Note 54), the *Registres* of the *Académie*, and the published work of the academicians. The last nine volumes contain treatises by the members of the *Académie*, some reprintings and others published now for the first time. Some of these are called *Histoire de l'Académie*, others *Mémoires de l'Académie*. To avoid confusion, we shall hereafter refer to them as " *Anc. Mém.*, Vol. II," etc.

(39) *Op. cit.*, Chapter I.

(40) See *Anc. Mém.* Vol. VIII, p. 495. CASSINI mentions an observation of the eclipse of the first satellite on October 22, 1668 at 10 h. 41 m. 33 s. as having been made by PICARD and as having been the first such in Paris. It is curious to note that in Facsimile XXI (at the end of this paper) this is the first observation in the list, although encircled with the phrase " excludio debet omnium suffragio " : no reason is given.

had arrived from Italy to be director of the *Observatoire* (41).

12. It was soon realized at the *Observatoire* that in order to make proper use of previous observations (especially those of HIPPARCHUS, PTOLEMY, and TYCHO) it was necessary to determine the precise position where these observations had been made. For this purpose, PICARD was sent on an official expedition by the *Académie* to determine the longitude of *Uraniborg* on the Island of Hveen (42). *Uraniborg* (a combination of a Greek and a Germanic word to give " city of heaven ") was the name given by TYCHO BRAHE (1546-1601) to his observatory. This determination was of particular importance as the best astronomical tables in use at this period were based on TYCHO's observations which had almost all been made at *Uraniborg*.

PICARD left Paris in July of 1671 and arrived in Copenhagen on August 24 of the same year. He did not reach *Uraniborg* until September 6 as he spent some time consulting with ERASMUS BARTHOLIN. He was accompanied on his visit to Hveen by BARTHOLIN and the latter's young assistant, OLE ROEMER. There, the party observed a series of eclipses of the first satellite of Jupiter while CASSINI made simultaneous observations in Paris, in accordance with the method just described (43). PICARD was

(41) GRANT (*op. cit.*, pp. 457-459) believes that PICARD would have been better choice for director than CASSINI, that there was no need to import a foreigner. PICARD, eclipsed by CASSINI's brilliance and out of favor with the court, never received his just measure of fame. It was PICARD, it will be remembered, whose measurement of the earth was used by NEWTON in his work on gravitation.

(42) See *Anc. Mém.* Vol. I, pp. 145-150. There is an amusing account given (p. 146) by FONTENELLE of the state in which *Uraniborg* was found.

> Uranibourg étoit entierement détruit. Ce fameux Observatoire, achevé de bâtir vers la fin de l'an 1580. n'avoit subsisté en son entier qu'environ 20. ans; & cependant TYCHO, qui tout grand Astronome qu'il étoit, avoit la foiblesse d'être aussi Astrologue, nous a appris lui-même qu'il avoit choisi un moment heureux pour poser la premiere pierre d'un bâtiment qui lui étoit si cher. Malgré les soins & les précautions du fondateur, les Astres ne regarderent pas favorablement un lieu qui leur étoit consacré; le nom d'Uranibourg, de Ville de Ciel, a été transporté à une Ferme; & M. PICARD eut la douleur de voir que le véritable Uranibourg n'étoit plus qu'une espéce d'enclos où l'on jettoit des carcasses de bêtes.

Cf. appendix to J. L. E. DREYER : *Tycho Brahe, a picture of scientific life and work in the sixteenth century*, Edinburgh, 1890.

See also CHARLES D. HUMBERD : TYCHO BRAHE's island, *Popular Astronomy*, Vol. 45, 1937, 118-125.

(43) For a generally interesting account of this use of astronomy see CASSINI :

much taken with young ROEMER and permitted him to make many independent observations (44). When finally he returned to Paris, PICARD brought with him two " treasures " in addition to a journal of eight months of observations. The first was the holograph manuscript of TYCHO's observations, valuable not for reasons of sentiment, but because these had never been properly edited.

Il compta aussi pour un des principaux fruits de son voyage, d'avoir amené en France avec lui un jeune Danois, nommé OLAÜS ROËMER, qui fut ensuite un des plus illustres membres de l'Académie des Sciences. C'est ainsi que la France faisoit toujours des acquisitions du côté de l'esprit, & s'enrichissoit de ce qui appartenoit naturellement aux Etrangers (45).

13. OLE [or OLAF or OLOF or, Latinized, OLAUS] CHRISTENSEN ROEMER was born in Aarhus, Denmark (Jutland) on September 25, 1644. His mother was ANNE MARIE STORM, his father CHRISTEN OLSEN ROEMER, a not particularly well-to-do merchant. Yet although he came " d'une famille peu avantagée du côté de l'état et de la fortune... le gout et le génie savent surmonter les obstacles " (46). He was sent, in 1662, to the University of Copenhagen where he studied under THOMAS BARTHOLIN (1616-1680), the professor of medicine, and under ERASMUS BARTHOLIN (1625-1698), also a physician, but famous for his discovery of double refraction in Iceland spar (47). ROEMER lived in the latter's house and under his direction studied mathematics and astronomy. BARTHOLIN found him to be both gifted and painstaking and entrusted him with the task of editing the manu-

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De l'Origine & du Progrès de l'Astronomie, & de son Usage dans la Géographie & dans la Navigation; *Anc. Mém.*, Vol. VIII, esp. pp. 48-52 or see his *Hypothèses et Tables, etc., op. cit.*, Section I, " Usage des Observations des Satellites de Jupiter dans la Géographie " or see *Philosophical Transactions*, Vol. XVIII, No. 213, September-October 1694, p. 237.

(44) See PICARD's own account of this : *Voyage d'Uranibourg ou observations astronomiques faites en Dannemarck*, Paris, 1680; reprinted in *Anc. Mém.* Vol. VII, Part I.

(45) *Anc. Mém.* Vol. I, p. 150.

(46) JEAN ÉTIENNE MONTUCLA : *Histoire des Mathematiques* (Nouvelle Édition), Paris An VII (1799), Vol. II, p. 582.

(47) The results of this work were published as—ERASMUS BARTHOLIN : *Experimenta crystalli islandici disdiaclastici quibus mira et insolita refractio detegitur*, Copenhagen, 1669.

script observations of TYCHO, at which task he was engaged when PICARD arrived in Copenhagen (48).

14. Upon his arrival in Paris, ROEMER was assigned lodgings in the newly completed observatory, where he lived until his departure from France. Soon after his arrival, he was made tutor to the *Dauphin* and was given a pension by LOUIS XIV in 1672 (49). He made many observations, both at Paris and in other parts of France whither he was sent by the *Académie;* some in his capacity as assistant to PICARD and CASSINI, and others completely independently of them (50). He displayed great mechanical and inventive genius and constructed many planispheres, a Saturnilabium, and a Jovilabium (of note as it enabled one to account for some of the irregularities in the motions of the satellites, and useful in computing tables). These were famous throughout Europe (51). He also invented a micrometer which was so superior to any designed previously, that it was speedily adopted for general use. He took part in the levellings prior to the con-

(48) See § 36.

(49) According to the *Annuaire pour* 1938, Académie des Sciences (Institut de France), ROEMER was not officially a member of the ACADÉMIE until he became " académicien astronome " in 1685. He became " associé étranger " on February 21, 1699 (at the same time as ISAAC NEWTON) and so was one of the " premier titulaires " to that distinction (there have never been more than eight such at one time). Yet MONTUCLA and others refer to his admission to the *Académie* in 1672, and his papers (for example the one in the *Journal des Sçavans*, see Note 64) refer to him as a member. ERNEST MAINDRON : *L'Académie des Sciences*, Paris, 1888, p. 31, lists the members of the *Académie* who were admitted from the foundation until 1669 and, in this list, mentions ROEMER as being admitted in 1672. Of course, he was part of the *Académie* staff in his capacity as assistant to CASSINI and PICARD, but whether or not he was an official " académicien " or not, I have been unable to determine.

(50) Many of these observations are mentioned in the eleven volumes of the *Anc. Mém.*, and others are to be found here and there in PIERRE CHARLES LE MONNIER : *Histoire Céleste ou Recueil de toutes les Observations Astronomiques faites par ordre du Roy ; Avec un Discours Préliminaire sur le Progrès de l'astronomie, où l'on compare les plus récentes Observations à celles qui ont été faites immédiatement apres la fondation de l'Observatoire Royal*, Paris, 1741. At the beginning of this book there is a non-paginated " Projet d'une Histoire Céleste qui doit comprendre les Observations Astronomiques faites en France depuis 1666," on the third page of which it is stated that " Les Observations que MM. AUZOUT & ROEMER ont faites du temps de M. PICARD, ont été entierement perdues, & il ne m'a pas été possible d'en recouvrer aucunes, quelques recherches que j'en aye faites."

(51) See *Machines et Inventions approuvées par l'Académie Royale des Sciences*

duction of water to Versailles and Marly and read many papers to the *Académie* on topics connected with this work (52).

In 1679, he was sent to England to examine the determination of the length of the seconds pendulum which was being made by the Royal Society and met, among others, NEWTON, HALLEY, and FLAMSTEED (53). It was in connection with his designing of machines, that he was led to consider what would be the best shape (in order to attain smoothness of action and minimal friction) for the teeth of gears. He was particularly interested in machines, such as hydraulic engines, for the lifting of great weights. In 1675 he read a paper on this subject at a meeting of the *Académie :* in it, he demonstrated that the best shape for such teeth was the epicycloid (54). Recognizing the importance of this discovery, he communicated his results immediately to HUYGENS, advising him to use such gears in his clocks (55). PHILIPPE DE LA HIRE

depuis son établissement jusqu'à present, avec leur description, Vol. I, 1666-1701, Paris, 1735 for the following machines of ROEMER :

Balance danoise et de sa division en proportion harmonique, p. 79.

Planisphére pour les étoiles et pour les planetes, p. 82.

Planisphere pour les eclipses, p. 85.

Construction de rouë propre à exprimer par son mouvement l'inégalité des revolutions des planetes, p. 89.

In *Anc. Mém.* Vol. I, there is mention of his " Régle universelle pour juger de la bonté des machines qui servent à éléver l'eau par le moyen d'une machine " and mention of the description given by PICARD of his " niveau."

(52) Among these are " De crassitie et viribus tuborum in aquaeductibus secundum diversas fontium altitudines, diversasque tuborum diametros " and " Experimenta circa altitudines & amplitudines projectionis corporum gravium instituta cum argento vivo," on pp. 708 and 711, respectively, of *Anc. Mém.*, Vol. VI.

(53) See THOMAS BIRCH : *History of the Royal Society of London for improving of Natural Knowledge*, Vol. III, London, 1757. On p. 482 we find " 1679, May 15 : Mons. ROEMER of the royal academy of sciences at Paris was admitted to be present."

(54) JEAN BAPTISTE DU HAMEL (" secrétaire perpétuel de l'Académie " 1666-1699) : *Regiae scientiarum academiae historia in qua praeter ipsius academiae originem & progressus, variasque dissertationes & observationes per triginta annos factas, quàm plurima experimenta & inventa, cum Physica, tum Mathematica in certum ordinem digeruntur*, Paris, 1698 : hereafter referred to as " *acad. hist.*" In Book II, Section II, Chapter III, § I, we find " D. ROËMER Tractatum à se elucubratum de Mechanicis, praesertium de rotis dentatis legit " : the original paper seems not to have been preserved.

(55) See HUYGENS : *Œuvres* (S.H.), Vol. XVIII, pp. 607-616. There one will also find a discussion by HUYGENS of the subject in general and of ROEMER's contribution in particular.

(1640-1718), who replaced ROEMER when the latter returned to Denmark, claimed this invention for his own as he did several others of ROEMER's (56) and although ROEMER (in Denmark) did not contradict him, other members of the *Académie* did. LEIBNIZ wrote to BERNOULLI in January of 1698, saying

> Dominus LA HIRIUS ipse, quod non Satis mirari possum, Epicycloïdum usum ad figuras dentium sibi tribuere videtur in peculiari de iis dissertatione, cum tamen certum sit inventum esse ROEMERI *Dani*; nam eram *Parisiis* eo tempore quo is invenit, remque non tantum ab ipso ROEMERO sed & HUGENIO intellexi (57).

15. DU HAMEL lists in his history an experimental determination of the velocity of sound by CASSINI, PICARD, and ROEMER (58). He also mentions a paper which ROEMER read to the *Académie* in 1677 in which he discussed DESCARTES' proof of the Law of Sines, explaining that the admission that light would travel faster in a denser medium was questionable. He preferred the seemingly more logical view that was the direct opposite of DESCARTES' : on which basis he gave a synthetic proof of the Law of Sines, similar to the analytical proof given by FERMAT (59). But of course, what was most important of all was his demonstration that light has a finite velocity and the first determination of that velocity (for which see Ch. III).

The last observation made by ROEMER in Paris is described by LE MONNIER as follows :

> Le 4 juillet 1681, on a fait une observation correspondante à celle du 7 juin, pour déterminer le solstice d'Été par la méthode de Mr. ROEMER, qui consiste à observer le lieu de l'image du Soleil transmise par un grand verre objectif sur la ligne méridienne (60).

ROEMER returned to his native land in 1681 to become professor of mathematics at the University of Copenhagen. Had he stayed in France, he would have felt the full force of religious intolerance

(56) P. DE LA HIRE : *Mémoires de mathématique et de physique contenant un traité de epicycloïdes, & de leurs usages dans les mechaniques...*, Paris, 1694; reprinted in *Anc. Mém.*, Vol. IX.

(57) *Virorum celebrr. Got. Gul. Leibnitii et Johan. Bernoullii commercium philosophicum et mathematicum*, Vol. I (1694-1699). Lausanne and Geneva, 1745, p. 347.

(58) *Acad. hist.*, Book II, Section III Chapter II, § X.

(59) *Acad. hist.*, Book II, Section IV, Chapter I, § VI.

(60) See C. WOLF : *Histoire de l'observatoire de Paris de sa fondation à* 1793, Paris, 1902, p. 84 or C. LE MONNIER, *op. cit.*, p. 252.

and bigotry, with which he had but slight encounter before his departure. For in 1685 LOUIS XIV revoked the Edict of Nantes, and ROEMER, a Protestant, would have been driven from the country, in company with that other " undesirable Protestant," CHRISTIAAN HUYGENS.

CHAPTER III

16. Since, as we have seen, the satellites of Jupiter were of extreme practical importance, it was necessary to know as much as possible of their irregularities. According to MARALDI I, JACQUES PHILIPPE MARALDI, the nephew and collaborator of CASSINI, " On appelle *premiere inégalité* des planetes celle qui vient de leur excentricité au Soleil, & qui est réellement dans leur cours par rapport à cet Astre, & *seconde inégalité*, celle qui vient de ce qu'elles sont vûes de la Terre, & non du Soleil " (61). CASSINI announced this " seconde inégalité " in August of 1675, remarking that this

> seconde inégalité paroît venir de ce que la lumière emploie quelque temps à venir du satellite jusqu'à nous, et qu'elle met environ dix à onze minutes à parcourir un espace égal au demi-diamètre de l'orbite terreste (62).

But " M. DE CASSINI ne demeura pas long-temps dans la pensée que la propagation successive de la lumiere produisit cette seconde inégalité " (63). And indeed he did not ! In fact, when ROEMER

(61) *Acad. Roy. Sci.*, 1704, *Histoire*, p. 70.

To supplement the eleven volumes containing the work of the *Académie* 1666-1699 (before its " renouvellement ") there were published a series of volumes (one for each year after 1699) entitled *Histoire de l'Académie Royale des Sciences, Année..., Avec les Mémoires de Mathématique et de Physique, pour la même Année.* Each volume is divided into two parts, with separate pagination; a résumé of the work for the year in question, and a collection of the more important papers read or published. To avoid confusion, we shall refer to p. 70 of the historical section as above, to the section of *Mémoires* as " *Acad. Roy. Sci.*, 1704, *Mémoires*, p. 70," etc.

(62) Quoted in MONTUCLA, *op. cit.*, Vol. II, p. 580. This is also mentioned in DU HAMEL : *Acad. hist.*, Book II, Section II, Chapter I, § IX. According to the account in *Acad. Roy. Sci.*, 1707, *Histoire*, p. 78; " M. CASSINI proposa cette pensée dans un Ecrit qu'il publia au mois d'Aoust 1674."

(63) This is very well stated in JEAN SYLVAIN BAILLY : *Histoire de l'Astronomie Moderne depuis la fondation de l'École d'Alexandrie jusqu'à l'époque de* MDCCXXX, Vol. II, Paris, 1785, p. 420.

> En la donnant [la découverte] à ROËMER, nous imitons D. CASSINI; nous osons conclure & de son aveu & de son abandon, qu'il n'en est point l'inventeur. C'est bien assez que son génie lui ait manqué pour saisir cette idée : née dans sa

read his classic paper on the subject, one of the strongest objectors was CASSINI himself. To him can be given no credit for the discovery—for a moment he entertained a hypothesis (one among others) but merely to discard it immediately.

17. As we have remarked in § 2, ROEMER predicted in September of 1676 that the eclipse of the first satellite of Jupiter which was supposed to take place on the following November 9 at 5h. 25m. 45s. would be 10 minutes late. On November 9, this eclipse was observed at the *Observatoire Royal* at 5h. 35m. 45s., in perfect confirmation of his prognosis. On the following 21 of November he read another paper to the members of the *Académie* in which he explained that the delay in the eclipse of the preceding November 9 showed the necessity of his new equation, the equation of light, (allowance for the time spent in light's passage) and that the time required for light to cross the diameter of the earth's annual orbit was about 22 minutes. An account of this paper was published shortly in the *Journal des Sçavans* (64) and an English translation appeared soon after (65). (These are reproduced at the end of this article as facsimiles XIX and XX). In his paper (66) ROEMER stressed what was for him the central point, that observations of immersions of the first satellite gave a smaller period of revolution than similar observations of emersions (67).

tête, elle eût été mieux considérée, plus approfondie; elle lui auroit été plus chère, si elle avoit été fille de son génie. Les premieres difficultés la lui firent rejeter comme une étrangere, au lieu que ROËMER prouve la 'paternité par l'attachement & par la constance. ROEMER soutint la propagation & la vîtesse mesurable de la lumiere; il n'abandonna point la vérité qui s'étoit montrée à lui, il a constaté ses droits & mérité sa gloire.

(64) *Journal des Sçavans*, December 7, 1676, pp. 233-36.

(65) *Philosophical Transactions*, Vol. XII, No. 136 June 25, 1677, pp. 893-94.

(66) *Acad. hist.*, Book II, Section II, Chapter I, §§ 10, 11. In the *Registres des procès-verbaux de l'ancienne Académie* (of these there are 109 volumes for the period 1666-1693, preserved in the archives of the present *Académie des Sciences*) there is to be found in Vol. VII, f. 63, verso,

Le Samedy 21 de Nov. [1676] Mons. ROEMER a leu a la compagnie un escrit, par lequel il monstre que le mouvement de la lumiere n'est pas instantané, ce qu'il fait veoir par l'inegalité des immersions, et émersions du premier satellite de Jupiter.

[28 Nov.] on a encore parlé des immersions et emersions du premier satellite de Jupiter, et de ce que la somme des immersions est plus courte que le temps des emersions.

These two excerpts are quoted in HUYGENS : *Œuvres* (S.H.) Vol. XIX, p. 432.

18. What was the immediate reaction to ROEMER's paper? CASSINI, although having once entertained the idea himself, objected vigorously. Not that there was any difference of opinion between them as to the fact of the delay : there could be none. The sole disagreement lay in accounting for that delay. CASSINI

> perceived that the successive propagation of light explained the irregularities in the eclipses of the first satellite when the Earth was in different positions of her orbit; but finding that it did not account in an equally satisfactory manner for the irregularities of the other satellites, he rejected it altogether, and instead of it he used in the tables of the first satellite an empiric equation depending on the relative positions of the Earth and Jupiter (68).

CASSINI, writing of this himself, says that

> le temps d'un nombre considérables d'immersions d'un même Satellite est sensiblement plus court que celui d'un nombre pareil d'émersions, ce qui se peut expliquer par l'hypothese du mouvement successif de la lumiere : mais cela ne lui [l'*Académie*] a pas paru suffisant pour convaincre que le mouvement de la lumiere est en effet successif, parce que l'on n'est pas certain que cette inégalité de temps ne soit pas produite ou par l'excentricité du Satellite, ou par l'irrégularité de son mouvement, ou par quelqu'autre cause jusques ici inconnuë, dont on pourra s'éclaircir avec le temps (69).

19. HUYGENS read the account of ROEMER's discovery in the *Philosophical Transactions;* wrote to him on September 16, 1677 (70) asking for more information and asking, too, whether or

(67) For a complete account of the motion of Jupiter's satellites, including a historical account of the first tables of their eclipses, see J. B. J. DELAMBRE : *Astronomie théorique et pratique*, Paris, 1814, Vol. III, Chapter XXXIV; " Des satellites."

Following the custom of the times, ROEMER observed immersions when the Earth was approaching Jupiter, emersions when the Earth was receding from Jupiter. See the first table in § 21, and cf. J. CASSINI, *Elemens d'Astronomie*, Paris, 1740; Livre ix — *Des Satellites de Jupiter & de Saturne.*

(68) GRANT : *op. cit.*, p. 80. The tables referred to are those published in 1693 (See Note 38). In § XVI, *Des inégalitez du mouvement des Satellites de Jupiter*, CASSINI says

> Monsieur ROMER explica très ingénieusement une de ces inégalitez qu'il avoit observées pendant quelques années dans le premier Satellite, par le mouvement successif de la lumiere, qui demande plus de temps à venir de Jupiter à la Terre lorsqu'il en est plus éloigné, que quand il en est plus près; mais il n'examina pas si cet hypothése s'accommodait aux autres Satellites qui demanderoient la même inégalité de temps. (*Anc. Mém.*, Vol. VIII, p. 391).

Cf. HALLEY's criticism of CASSINI on this point in § 24. See also Note 102.

(69) *De l'origine... de l'Astronomie...* (See Note 43), *Anc. Mém.*, Vol. VIII, p. 47.

(70) HUYGENS : *Œuvres* (S.H.), Vol. VIII, Letter 2103.

not the figures, 22 minutes, were correct. He thought, as well, " Caeterum quia in diario Londinensi nonnihil a mente tua aberrasse interpres videtur, vellem ut pagellam e diario vestro Gallico ad me mittas quae tua verba continet, non enim adhuc videre contigit." (71) In his reply, ROEMER admitted to the figure of 22 minutes, saying, " Errores nihilominus calculi siqui sunt mihi soli sunt imputandi." (72) He listed a set of four reasons for the fact that similar computations based on the other three satellites would give no results, and also attempted to show why the delay, " mora luminis," could come from no other cause. HUYGENS was completely convinced (73).

20. The observation of November 19 was seeming confirmation of " mora luminis." Yet, according to FONTENELLE,

> Malgré ce succès, comme la pensée étoit fort nouvelle, on ne s'y rendit pas encore; on fut en garde contre les charmes de la nouveauté, Le Satellite n'a pas exactement pour centre de son mouvement, le centre de Jupiter. De plus... On imagina même une autre hipothése Astronomique, qui ajustoit tout; mais elle étoit trop différente de tout ce que l'on connoissoit d'ailleurs dans le Ciel. Elle pouvoit bien satisfaire par le calcul à toutes les Observations; mais elle n'avoit pas une certaine vrai-semblance qui satisfît l'esprit...

But after all, argued FONTENELLE

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(71) See § 41.

(72) HUYGENS : *Œuvres* (S.H.), Vol. VIII, Letter 2104. The remainder of the HUYGENS-ROEMER correspondence 2107, 08, 09, 10, 11, 12, 13, 14, 15 are all of interest, but most of these letters do not refer directly to the subject in hand.

(73) HUYGENS wrote to COLBERT on October 14, 1677 (after receiving the first letter from ROEMER) saying

> J'ai veu depuis peu avec bien de la joye la belle invention qu'a trouvè le Sr. ROEMER, pour demonstrer que la lumiere en se repandant emploie du temps, et mesme pour mesurer ce temps, qui est une decouverte fort importante... Pour moy cette demonstration m'a agréee d'autant plus, que dans ce que j'ecris de la Dioptrique j'ay supposè la mesme chose touchant la lumiere... (*Œuvres* (S.H.) Vol. VIII, Letter 2105)

In notes made by HUYGENS for this *Dioptrique* [in 1673] we find,

> lumiere s'estend circulairement et non dans l'instant, au moins dans les corps icy las. car pour la lumiere des astres il n'est pas sans difficultè de dire qu'elle ne seroit pas instantanee. (*Œuvres* (S.H.), Vol. XIII, p. 742).

In Chapter I of his *Traité de la Lumiere*, HUYGENS gives in complete detail ROEMER's demonstration of the finiteness of the velocity of light and accepts uncritically his figure of 22 minutes for light to cross the diameter of the Earth's orbit. (Cp. Note 24).

Pourquoi la Lumiere pourroit-elle traverser une espace en un instant, plûtôt que le son, ou pour parler encore plus philosophiquement, plûtôt qu'un bloc de marbre ? ... Le mouvement d'un bloc de marbre prouve pour celui de la lumiere la nécessité de quelque durée. Le mouvement du son qui se répand si vîte n'est en effet, à l'égard de celui de la lumiere, que le mouvement d'un bloc de marbre élevé à grande peine par une gruë (74).

In the course of the ensuing controversy, ROEMER read aloud the letters of HUYGENS to support him before the *Académie*. But although many academicians were convinced of the necessity of the equation of light, the CASSINI family as a whole remained a stronghold of reaction. The objections were voiced in what seemed a decisive paper by MARALDI I, who devoted much time to the study of Jupiter's satellites. In this paper (75), delivered in 1707, he admitted, in common with his uncle, that the equation of light gave a very satisfactory explanation and account of the errors of the first satellite; but, he maintained, it should vary from the perihelion to the aphelion of Jupiter's orbit. Also, the errors should be the same for all the satellites. (It did not occur to him that there might be still other errors in the three outer satellites). After this paper was delivered, FONTENELLE was won away from ROEMER's " theory." He informs us how beguiling he had thought the idea of " mora luminis " was, he repeats the simile of the " bloc de marbre " (but just " pour parler encore plus philosophiquement ") and then laments that

Il paroît donc qu'il faut renoncer, quoique peut-être avec regret, à l'ingenieuse & séduisante hypothèse de la propagation successive de la lumière... A quoi tient-il que nous ne tombions pas dans de grandes erreurs ! Si Jupiter n'eût qu'un Satellite, & si son excentricité à l'egard du Soleil eût été moindre, & ces deux choses-là étoient fort possibles, nous serions tenus sûrs que la lumiere traversoit en 14′ l'Orbe annuel de la Terre (76).

21. It is of some interest to examine closely the means whereby ROEMER arrived at his figure of 22 minutes (77). This is possible

(74) *Anc. Mém.*, Vol. I, pp. 213-16.

(75) JACQUES PHILIPPE MARALDI : Considerations sur la seconde inégalité du mouvement des Satellites de Jupiter, & sur l'hypothese du mouvement successif de la lumiere; *Acad. Roy. Sci.*, 1707. *Mémoires*, pp. 25-32.

(76) *Acad. Roy. Sci.*, 1707, *Histoire*, pp. 77-81.

(77) Cp. ALEX. WERNICKE : Die Entdeckung der endlichen Lichtgeschwindigkeit durch OLAF ROEMER; *Zeitschrift für Mathematik und Physik (Historisch-literarische Abtheilung)*, Vol. XXV, 1880, pp. 1-10, remembering that the materials mentioned in § 21 had not as yet been discovered; this account is somewhat out of date.

since the discovery, in the summer of 1913, of a manuscript folio containing a list of the eclipses of the satellites of Jupiter for the years 1668-1677; the handwriting is ROEMER's (78). ROEMER had intended to publish a more complete work, giving the data on which he had based his conclusions, but like so many other intentions of his to publish, this was never realized (79).

In the letter to HUYGENS of December 30, 1677 (80), ROEMER said that he had collected more than 70 observations of the first satellite, these made by PICARD and himself since 1668. These he had studied very carefully, dividing them into the following nine periods :

Period	I	Earth	receding from	Jupiter	Mar.	1671—	May	1671 Emersions
»	II	»	approaching	»	Oct.	1671—	Feb.	1672 Immersions
»	III	»	receding from	»	Mar.	1672—	June	1672 Emersions
»	IV	»	approaching	»	Nov.	1672—	Mar.	1673 Immersions
»	V	»	receding from	»	Apr.	1673—	Aug.	1673 Emersions
»	VI	»	receding from	»	July	1675—	Oct.	1675 Emersions
»	VII	»	approaching	»	May	1676—	June	1676 Immersions
»	VIII	»	receding from	»	Aug.	1676—	Nov.	1676 Emersions
»	IX	»	approaching	»	June	1677—	July	1677 Immersions

The observations of the first satellite (that part of the manuscript

(78) This manuscript is reproduced, together with an elaborate analysis by Dr. KIRSTINE MEYER in an article: Om OLE RØMERS Opdagelse af Lysets Tøven, *Kongelige Danske Videnskabernes Selskabs Skrifter (Naturvidenskabelig of mathematisk afdeling)* Series 7, Vol. XII, 1915, pp. 106-45. One part of this manuscript is reproduced in this paper as facsimile XXI.

(79) ROEMER read a later paper to the members of the *Académie* in 1677, *Confirmatio doctrinae de Mora Luminis ex novis Observationibus anni*, 1677. This was published for the first time in HUYGENS : *Œuvres* (S.H.), Vol. VIII, pp. 56-58, where it is said to be found in the *Registres* (See Note 66) Vol. VII, p. 141 verso under the date March 26, 1678, preceded by the following note of DU HAMEL

> Mr. CASSINI a remis entre mes mains l'escrit de Mr. ROEMER qui confirme son sentiment touchant le retardement de la lumière depuis Jupiter jusqu'à nous dont suit la copie.

See also *Acad. hist.*, Book II, Section VI, Chapter I, § 7. In this report, ROEMER announced that further observations had led him to conclude from observations of a spot on Jupiter that it required 14^m for light to traverse 1 1/4 *r*, and from observations made on the first satellite during the same year 12^m for light to cross the same distance; to give respectively 11^m 1/4 and 9^m 3/5 to cross *r*, the radius of the Earth. In these results ROEMER saw a confirmation of his hypothesis of " mora luminis " and added that the uncertainty of knowledge with regard to the period of revolution did not permit of exact determination of the time of transmission.

reproduced as facsimile XXI) number 67 : of these 2 are incomplete, others merely refer to the passage of the satellite across the face of Jupiter, and the remaining 51 fall into the periods of this list. Dr. MEYER has computed the mean period of revolution of the first satellite for each of these periods, on the basis of the data in the manuscript (81) to get

Period	I	1d.	18h.	28m.	47s. Emersions
»	II	1	18	28	18 Immersions
»	III	1	18	28	35 Emersions
»	IV	1	18	28	27 Immersions
»	V	1	18	28	46 Emersions
»	VI	1	18	28	48 Emersions
»	VII	1	18	28	20 Immersions
»	VIII	1	18	28	47 Emersions
»	IX	1	18	28	30 Immersions

in confirmation of ROEMER's statement that the mean period is always greater when calculated on the basis of emersions than when calculated on immersions.

22. Another salient point mentioned by ROEMER in his first letter to HUYGENS is that in order to obtain his figure of 22 minutes for light to cross the diameter of the earth's orbit, he purposely chose those observations made during the years 1671, 1672, 1673. This, because he had at his disposal a large number of observations for that period of time. (A glance at the facsimile shows that more than half of the observations on the list are for these three years.) Also, for the important reason that Jupiter offered, during this period, comparatively few variations in its movement and distance from the sun; this because 1672 marked the aphelion passage of Jupiter.

On a portion of the folio not reproduced here, there are computations giving the mean period of revolution for the first satellite as follows :

1671-1672	1d.	18h.	28m.	30s.
1672-1673	1d.	18h.	28m.	31s.

(80) In this letter ROEMER expresses the hope of obtaining a leave of absence from his work at the observatory in order to go to Holland to consult with HUYGENS about the projected publication.

(81) *Op. cit.* (note 78) pp. 114-17.

23. With these figures it is a simple matter to recompute the equation of light on ROEMER's data. Beginning with October 24, 1671 there are listed a series of immersions, of which the last two (February 11 and February 20, 1672) are marked doubtful. Let us consider the last one preceding this pair, that of January 12, 1672.

1671 October	24d.	18h.	15m.		Solar Time
			—15m.	45s.	Equation of Time
	297d.	17h.	59m.	15s.	Mean Time
1672 January	12d.	8h.	59m.	22s.	Solar Time
			+ 9m.	23s.	Equation of Time
	12d.	9h.	8m.	45s.	Mean Time

Subtracting, we get

1672	12d.	9h.	8m.	45s.
1671	297d.	17h.	59m.	15s.
	79d.	15h.	9m.	30s.

For the same period of time, the mean period of revolution was 1d. 18h. 28m. 30s. and as there were 45 revolutions of the satellite between October 24, 1671 and January 12, 1672, the eclipse should have taken place at 45 (1d. 18h. 28m. 30s.) = 79d. 15h. 22m. 30s. A comparison of this figure with the one above shows that the immersion of January 12 occurred 13 minutes earlier than it would have been expected. But during this period (between the two eclipses used in the computation) the distance from the earth to Jupiter had diminished by 1.21 r (r is the radius of the earth's orbit) from which we get the time required for light to traverse the distance r as

$$\frac{13 \text{ min.}}{1.21} = 10\text{m. } 45\text{s.}$$

or about 11 minutes, as given by ROEMER.

On another portion of the ROEMER manuscript there are to be found such figures as

10	9	10	29	
11	11	12	2	
21	20	11	15	(10 25 is an obvious
10	25			error for 10 40.)

which would seem to represent averages of computed times for light to cross the distance r.

24. According to the report made by ROEMER to the *Académie* in 1676, there was a ten minute delay in observation, which he announced was confirmation of " mora luminis." But according to the calculation made by Dr. MEYER, the increment in the distance from Jupiter to the earth between August 23 (the last eclipse on ROEMER's list before that of November 9, and the one on which it is probable he based his startling prediction) and November 9 of 1676 was $1.14r$, so that had ROEMER calculated the time for light to cross the radius of the earth's orbit on this rather than on the 1671-1673 period, he would have got from the ten minute delay

$$\frac{10 \text{ min.}}{1.14} = 8.7 \text{ min.}$$

a figure much closer to the correct value than that of 11 minutes.

The present writer has found, strangely enough, that for all the importance given by ROEMER and others to the fact that the November 9 eclipse took place exactly ten minutes late or at exactly 5h. 35m. 45s. (for which see facsimile XIX, the paragraph next to the last), this eclipse, an emersion, is listed by LE MONNIER (82), whose record has the stamp of officialism, as having been observed at 5h. 37m. 49s. If this were actually the case, the eclipse would have taken place, not 10^m late, but rather about 12^m late so that using Dr. MEYER's figure we would get

$$\frac{12.08 \text{ min.}}{1.14} = 10.6 \text{ min.}$$

practically the 11^m of ROEMER (83).

(82) *Op. cit.*, p. 219.

(83) I mention this merely because it is so strange. Of course, if the eclipse

25. We have seen that in France, ROEMER's innovation was not generally accepted; indeed such was not the case until the startling independent confirmation by BRADLEY in January of 1729. But by that time, the idea that the velocity of light was finite had gained much headway in England and elsewhere (84). ISAAC NEWTON wrote in his *Principia* in 1686 (85)

> Namque Lucem successive propagari & spatio quasi decem minutorum primorum a Sole ad Terram venire, jam constat per Phaenomena Satellitum *Jovis*, Observationibus diversorum Astronomorum confirmata.

WILLIAM MOLYNEUX gives a much more complete account, saying that (86) light

> requires *time* to pass from one place to another, and does it not in an *instant*,... He that requires a farther Account hereof may consult the *Journal des Scavans* 1676. Decembr. 7. *Philosoph. Transact.* Num. 136. or Mr. R. NEWTON's Incomparable Piece, *Philosophiae Natur. Princ. Mathem. Lib.* I *Schol. Prop.* 96. Where 'tis asserted, That Light requires about ten Minutes time to cross from the Sun to the Earth... But by this allowance [" for the Time spent in Lights Motion "] they [the eclipses of the satellites of Jupiter] answer to the greatest exactness... For a confirmation of all which I appeal to the Labours of the Ingenious Mr. Flamsteed and Mr. Halley, to whom the Learned World is for ever obliged by their Advancements of Astronomy.

26. FLAMSTEED, according to a letter that HUYGENS wrote to LA HIRE (87) in May of 1690, had told HUYGENS that he was

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took place at the time given by LE MONNIER, the delay would have been greater by a little more than two minutes, than that predicted by ROEMER in the preceding September.

(84) In England, HOOKE alone was not convinced by ROEMER. In the pre-ROEMER period HOOKE *doubted* the *instantaneous* transmission of light (See § 10). After ROEMER's demonstration, he *doubted finite* transmission. In his " Lectures of Light ", read 1680-1682 (*Posthumous works*, London, 1705; section I), he says :

> Supposing this [ROEMER's demonstration] may prove it [light] to be temporary and not instantaneous, yet we find that it is so exceeding swift that 'tis beyond Imagination; for so far he thinks indubitable, that it moves a Space equal to the Diameter of the Earth, or near 8000 Miles, in less than one single Second of the time, which is in as short time as one can well pronounce 1, 2, 3, 4 : And if so, why it may not be as well instantaneous I know no reason.

(85) *Philosophiae Naturalis Principia Mathematica*, London, 1687 (bearing PEPYS' authorization as of July 5 1686); Scholium to Proposition XCVI, Theorem L.

(86) WILLIAM MOLYNEUX : *Dioptrica Nova : A treatise of Dioptrics*, London, 1692, Part II; Chapter I, " Of Refraction and Light " § 7, " Its Requiring time to move from place to place."

(87) *Œuvres* (S.H.), Vol. IX, Letter 2585.

making use of the equation resulting from the time employed by light in its passage in accordance with the work of ROEMER (88). HALLEY, too, was convinced of the necessity of this new equation. In 1694 he published CASSINI's tables of the first satellite of Jupiter (reduced to the Julian style and to the meridian of London); in the introduction, discussing the second inequality, he remarks that CASSINI admits that

> Monsieur ROEMER did most ingeniously explain [this second inequality] by the Hypothesis of the progressive Motion of Light; to which yet CASSINI by his manner of calculus seems not to assent, though it be hard to imagine how the Earth's Position in respect of *Jupiter* should any way affect the motion of the *Satellites*... But what is most strange, he affirms that the same Inequality of two Degrees in the Motion, is likewise found in the other Satellites, requiring a much greater time, as above two Hours in the fourth *Satellite* : which if it appeared by Observation, would overthrow Monsieur ROMER's Hypothesis entirely. Yet I doubt not herein to make it demonstratively plain that the Hypothesis of the progressive Motion of Light is found in all the other *Satellites* of *Jupiter* to be necessary, and that it is the same in all;...

Then follow the tables (89). But in a postscript, supposedly a set of directions as to their use, HALLEY declares that

> As to the Second Aequation of the other *Satellites*,... if this second Inequality did proceed from the successive propagation of Light, this Aequation ought to be the same in all of them, which Monsieur CASSINI says was wanting to be shewn, to perfect Monsieur ROMER's Demonstration; wherefore he had rejected it as ill founded. But there is good cause to believe that his motive thereto, is what he has thought not proper to discover. And the following Observations do sufficiently supply the Defect complained of in the making out of that Hypothesis. (90)

To support this contention, he lists some observations of his own and some of FLAMSTEED's, and notes that ROEMER's figure of 11 minutes is too large and that the figure computed by CASSINI (as a time of delay, with no clue to the cause) is too small, being only 7 minutes 5 seconds. The correct figure, says HALLEY, is closer to 8 1/2 minutes.

(88) In FLAMSTEED's tables; *Historia Coelestis Britanica*, London, 1725, use is made of the equation of light, especially for computations with respect to the satellites of Jupiter.

(89) HALLEY's article is entitled—*Monsieur Cassini his New and Exact Tables for the Eclipses of the First Satellite of Jupiter, reduced to the Julian Stile, and Meridian of London.* It appeared in the *Philosophical Transactions*, Vol. XVIII, Number 214, Nov.-Dec. 1694, pp. 237-56. The tables of CASSINI are those published by him in 1693, *op. cit.* (Note 38).

(90) Cf. Note 102.

27. In the *Opticks* published first in 1704, NEWTON has two direct references to the velocity of light. In the first of these, at the very start of the book (91), he mentions that most people consider light to be propagated instantaneously and so initially he defines rays, refractions, etc. in accordance with that belief.

> But by an Argument taken from the Aequations of the times of the Eclipses of *Jupiter's Satellites*, it seems that Light is propagated in time, spending in its passage from the Sun to us about seven Minutes of time : And therefore I have chosen to define Rays and Refractions in such general terms as may agree to Light in both cases.

Was NEWTON just " playing safe "? It seems not. In so far as the materials treated in Book I were concerned, it did not much matter whether be assumed the propagation to be instantaneous or gradual. NEWTON merely wished to avoid commitment to one point of view or the other as long as possible. (It will be remembered with what dread NEWTON viewed controversies.) But when he had reached that part of the book where " the last proposition depended on the velocity of Light," he introduced the proposition (92) that " Light is propagated from luminous Bodies in time, and spends about seven or eight Minutes of an Hour in passing from the Sun to the Earth." He adds that this " was observed first by ROEMER, and then by others, by means of the Eclipses of the Satellites of Jupiter," and after explaining how one derives the fact of " mora luminis " from these eclipses, notes that

> Some inequalities of time may arise from the Excentricities of the Orbs of the Satellites; [etc.]... But this inequality has no respect to the position of the Earth, and in the three interior Satellites is insensible, as I find by computation from the Theory of their Gravity.

(91) *Opticks : or, a Treatise of the Reflexions, Refractions, Inflexions and Colours of Light. Also Two Treatises of the Species and Magnitude of Curvilinear Figures.* London, 1704. Book I, Part I, Definition 2.

(92) *Opticks*, " The Second Book of Opticks," Part III, Proposition XI.

In 1706, *Les Nouvelles de la République des Lettres* published a description of NEWTON's *Opticks*, translating some of the sections into French. In May, there appeared a translation of this proposition, mentioning ROEMER's name and the figure 8^m. ROEMER must have been pleased by the reference (although probably surprised by the figure given for the equation of light) and wrote in his commonplace book *Adversaria* (See Note 113) p. 4, in a list of entries made from the above mentioned journal,

> 1706 Maji pag. 567. NEWTON in optica jam fatetur de luminis mora qvod ROMER et postea multi demonstrarint eam ex satellitibus 2$\frac{1}{4}$ (sed ponit a Sole ad terram saltem 8′) HUGEN. de lumine 600 000 lumen celerius sono.)

It should be noted that the time is no longer given as ten minutes (as in the first edition of the *Principia*) but as seven or eight minutes. Whether this resulted from his own computation or from that of HALLEY or FLAMSTEED, we have no way of knowing. Of course, once ROEMER had described his method, it was a simple matter for anyone else to repeat his work : all that was needed was a set of tables. Newton was consistent with regard to the amount of time and in the second edition of the *Principia* (revised by himself) the statement quoted in § 25 becomes (93) " Namque Lucem successive propagari & spatio quasi septem vel octo minutorum primorum a Sole ad Terram venire, ... " (94).

28. It is not worth while to list all of the evaluations given in contemporary treatises. BRADLEY discovered the aberration of light and published his findings in 1729 (95) confirming ROEMER's " mora luminis " independently. He deduced, from his value of the constant of aberration, that the time required for light to travel from the sun to the earth should be $8^m\ 12^s$, a figure much closer to NEWTON's and HALLEY's than ROEMER's; remarking that

> It is well known that Mr. ROEMER... supposed that it [light] spent about 11′ Minutes of Time in its Passage from the Sun to us : but it hath since been concluded by others from the like Eclipses, that it is propagated as far in about 7 Minutes. The Velocity of Light therefore deduced from the foregoing Hypothesis [the aberration] is as it were a *Mean* betwixt what had at different times been determined from the Eclipses of Jupiter's Satellites (96).

BRADLEY's work led to the final acceptance of the finite propagation of light. Even the CASSINI family had to give in. MARALDI II, who began his career in the CASSINI tradition by denying the " mora luminis " of ROEMER, published a paper in 1741 in which he showed (97) that the equation of light explained much of the irregularity in the motion of the third satellite.

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(93) *Philosophiae Naturalis Principia Mathematica*, Cambridge, 1713.

(94) The third edition, London, 1726, is identical with the second on this point.

(95) See GEORGE SARTON : Discovery of the aberration of light, *Isis*, Vol. XVI, 1931, pp. 233-39.

(96) *Philosophical Transactions*, Vol. XXXV, 1729, No. 406, p. 653. There is a facsimile of this announcement by BRADLEY in the *Isis* article of Note 95.

(97) See the account in *Acad. Roy. Sci.*, 1741, *Histoire* pp. 113-15 or JEAN DOMINIQUE MARALDI : Reflexions sur la Theorie du troisieme Satellite de Jupiter; *Acad. Roy. Sci.*, 1741, *Mémoires*, pp. 1-10.

29. DELAMBRE wrote that from an examination of the eclipses of Jupiter's satellites for 150 years the figure he had arrived at was $8^m\ 13.2^s$ (98). WHITTAKER mentions (99) an inaugural dissertation of 1875 by GLASENAP who, discussing the eclipses of the first satellite between 1848 and 1870, derived values between $8^m\ 16^s$ and $8^m\ 21^s$, the most probable being $8^m\ 20.8^s$. He also mentions the work of SAMPSON, who in 1909 derived the value $8^m\ 18.64^s$ from his own reductions of the Harvard observations and $8^m 18.79^s$ from the Harvard reductions, with probable errors of $\pm\ 0.02^s$.

The most recent determination for the time of transit from the Earth to the Sun is that of BROUWER (100) who from a value of $8.8030''$ ($\pm 0.0020''$) for the solar parallax, derives the value $8^m\ 19^s$. That ROEMER's figure was too large, a little less than a third larger than the most recent value, is of little or no discredit. At a time when the general belief was that the velocity of light was instantaneous, he offered a means of contradicting that belief that convinced the major portion of the scientists of his time. If his figure was a little large, it was, in any case, of the right order of magnitude. We can but repeat with HUYGENS (101) who wrote to ROEMER, with regard to the tremendously large velocity,

> quanto videtur incredibilius tanto pulchrius divinisque censeri debet si certa ratione comprobetur (102).

CHAPTER IV

30. ROEMER returned to Denmark in 1681 to become professor

(98) JEAN BAPTISTE JOSEPH DELAMBRE : *Tables écliptiques des satellites de Jupiter*, Paris, 1817.

(99) E. T. WHITTAKER : *A history of the theories of aether and electricity from the age of Descartes to the close of the nineteenth century*, Dublin, 1910, p. 22.

(100) W. DE SITTER : On the system of astronomical constants (ed. with notes by D. BROUWER), *Bulletin of the Astronomical Institute of the Netherlands*, Vol. VIII, 1938, pp. 213-31.

Cf. M. E. J. GHEURY DE BRAY : The velocity of light, history of its determination from 1849 to 1933, *Isis*, Vol. XXV, 1936, pp. 437-48.

(101) *Œuvres* (S.H.), Vol. VIII, Letter 2103.

(102) It should be noted finally that the outer satellites did not exhibit the time equality mentioned by ROEMER with the same regularity as the innermost, chiefly because the motions of these other three are greatly affected by mutual perturbations extending over a 486.5 day period due to the libration of the satellites. The physical cause of this remained unknown until LAPLACE's work of 1784 : the simple fact of the libration seems to have been known to BRADLEY from his observations as early as 1740.

of mathematics in the University of Copenhagen and he was soon after appointed Astronomer Royal to CHRISTIAN V. This intelligent monarch was quick to recognize ROEMER's great and varied technical knowledge and we find him appointed master of the mint, purveyor of the harbours, inspector of naval architecture and advisor on pyrotechnics and ballistics. He was also appointed head of a commission to inspect and measure the highways of the realm, and after distinguished service in all of these capacities was appointed in 1688 to be a member of CHRISTIAN's privy council. In 1693 he became first magistrate (equivalent to chief justice of the supreme court) of Copenhagen and the following year was appointed chief tax assessor, in which capacity he devised an efficient system of equitable and uniform taxation. He was appointed mayor of Copenhagen in 1705 and soon after, prefect of police as well. FREDERICK IV, who succeeded CHRISTIAN V, made him a senator in 1705 and in 1707 made him head of the state council. In all of these many capacities, he served his country honourably and faithfully, leaving behind him a distinguished record (103).

31. In 1687, he was sent on a voyage to France, England, the Netherlands and Germany in order to gain information about harbour improvements, mechanical and industrial innovations, scientific developments, as well as to negotiate trade agreements. Like BRADLEY, ROEMER was interested in calendar reform. Fortunately, however, ROEMER escaped the persecution which followed BRADLEY's efforts to introduce the "popish" calendar into England, although ROEMER, like BRADLEY, was a Protestant in a Protestant country. It was part of ROEMER's duty as Astronomer Royal to present each year an almanac compiled by himself and his assistants. This he would deliver personally to his king. ROEMER took advantage of the audiences accompanying this presentation to convince CHRISTIAN that the Gregorian calendar had so many advantages that it was almost a necessity for Denmark to adopt it. CHRISTIAN, finally convinced, authorized ROEMER to negotiate the matter with the Swedish government as he thought

(103) ROEMER also was responsible for the reorganization and standardization of the system of weights and measures. Some of ROEMER's elements have survived the introduction of the metric system.

it best for both Scandinavian countries to effect the change simultaneously.

Accordingly, ROEMER put the proposal before the Swedish royal council which after much procrastination referred the whole matter to one ANDREW SPOLE, a professor of mathematics at Uppsala. The affair dragged on and on and when ROEMER pressed SPOLE for a definite statement, the latter refused to recommend the Gregorian calender. Instead, he offered a compromise in the form of his own calendar, a " natural " calendar supposedly based on the movement of the stars. ROEMER attempted to show him what confusion already existed because there were two calendars in existence at the same time, and how much more confusion there would be if there were three, but all to no avail. ROEMER was forced to recommend that Denmark reform its calendar independently of Sweden, and perhaps hope that the neighboring country would follow suit in the not too distant future. This was not done, however, until FREDERICK announced that in 1710, February would have but 18 days and that Easter would fall on the 11 of April. Unfortunately, there was no clear provision made for future reckoning of Easter and about twenty years later all of the old problems reappeared. Had ROEMER been alive when the announcement of the reform was made, it is almost certain that such provision would have been made (104).

32. Of great importance is ROEMER's work on the thermometer. ROEMER constructed many thermometers and used them in his astronomical work as well as to record the daily temperature. These thermometers were designed by him and were superior to any that had been used previously. He it was who first realized that the scales of thermometers giving concordant readings must be based on *two* fixed points, not just one. The two points he used were the boiling point of water (which he marked at 60°)

(104) J. B. J. DELAMBRE : *Histoire de l'Astronomie moderne*, Paris, 1821, Vol. II, pp. 659-61. Cf. Note 113.

For a complete history of this, see P. HORREBOW (Cf. Note 107), Actorum circa reformationem calendarii; Narratio historica ex documentis authenticis, *Operum mathematico-physicorum*, Vol. II, Copenhagen, 1741, pp. 1-172. This work contains many of the official statements made by the rulers of Denmark and Sweden, plus the correspondence in this regard between ROEMER and JOHANN MEYER (pp. 106-133) and between ROEMER and LEIBNIZ.

and the melting point of snow or crushed ice (which he marked at 7° 1/2, so that a mixture of crushed ice or snow and sal ammoniac would give a zero reading). In a letter written to BOERHAAVE in 1729, FAHRENHEIT (1686-1736) states that he met ROEMER in Copenhagen in 1708 and from him learned the fundamental

BASIS ASTRONOMIÆ
Sive
ASTRONOMIÆ PARS MECHANICA
In qva Deſcribuntur Obſervatoria, atqve Inſtrumenta Aſtronomica Rœmeriana Danica; ſimulqve eorundem uſus,
Sive
METHODI OBSERVANDI ROEMERIANÆ
In uſum publicum, & præſertim in gratiam una prodeuntis valde inſignis atqve uſûs ampliſſimi, nunqvam non poſteris memorandi

TRIDUI
OBSERVATIONUM TUSCULANARUM
ROEMERI
Ex Fundamentis Exponuntur
a
PETRO HORREBOWIO
Philoſophiæ & Medicinæ Doctore,
In Univerſitate Havnienſi Aſtronomiæ Profeſſore
ac Societatis Artium Pariſienſis membro.

HAVNIÆ,
Apud Viduam beati Hieron. Chriſtiani Paulli
Anno MDCCXXXV.

FIG. 1.
Title page of HORREBOW's account of ROEMER's work
(See Note 107)

principle of the two fixed points. Also, that he saw ROEMER in the process of testing small thermometers for meteorological use : these were divided into 22 1/2 parts and had as fixed points 7° 1/2 (ice water) and 22° 1/2 (blood heat). FAHRENHEIT adds (105)

(105) For ROEMER's work on the thermometer see KIRSTINE MEYER : *Temperaturbegrebets Udvikling gennem Tiderne og dets Forhold til vekslende Anskuelser om*

that he himself adopted the same temperature scale, but with two minor changes. These were the use of ROEMER's zero (snow and sal ammoniac) as the lower fixed point rather than 7° 1/2, a convenience pure and simple, and the use of a scale division arrived at by dividing each of ROEMER's scale divisions into four such, for ease of reading. FAHRENHEIT kept the scale in this form, with 90 divisions, until 1717. At that time, in order to avoid the clumsiness of fractions, he replaced the 90 divisions by 96. He " retained ROEMER's general arrangement whereby one-third of the whole range lay between the zero and the melting-point, and two-thirds between the melting-point and blood temperature; the melting-point thus became 32° and blood temperature 96° " (See HEATHCOTE's article, Note 105). Thus it is quite clear that it was ROEMER who invented the modern thermometer and that the FAHRENHEIT thermometer should, in all fairness, be called the ROEMER thermometer !

33. What we have mentioned thus far in this chapter is sufficient to fill a life-time well spent. Yet, fantastic as it sounds, during this same period, in addition to his work at the University of Copenhagen, ROEMER made fully as many observations as the great TYCHO, and designed and constructed astronomical instruments so efficient and so far ahead of their day, that he must certainly be rated as one of the greatest practical astronomers of all time.

As Astronomer Royal, ROEMER was automatically the director of the Copenhagen Observatory, one of the oldest in Europe. The observatory was housed in the " Round Tower " (See fig. 2) which had been built by CHRISTIAN IV in 1637 for TYCHO's assistant LONGOMONTANUS (106). ROEMER made some observations from

Varmens Natur, Copenhagen, 1909 (Also available in German translation). See also § 38.

The FAHRENHEIT letter may be found in the article on him in the *Kon. Akad. Wet. Verhand.* (Eerste Sectie), Vol. xvi, Amsterdam, 1936, pp. 1-37. The portion referred to has been translated by the authors, ERNST COHEN and W. A. COHEN-DE MEESTER, from the original Dutch into German. The article has been summarized by N. H. DE V. HEATHCOTE in *Annals of Science*, Vol. II, 1937, pp. 133-134. The FAHRENHEIT letter is one of a set recently discovered in Leningrad.

(106) For a description of this old building see GRANT, *op. cit.*, or FLORIAN CAJORI : Four old astronomical observatory buildings; *The Scientific Monthly*, Vol. XXVI, 1928, pp. 372-76.

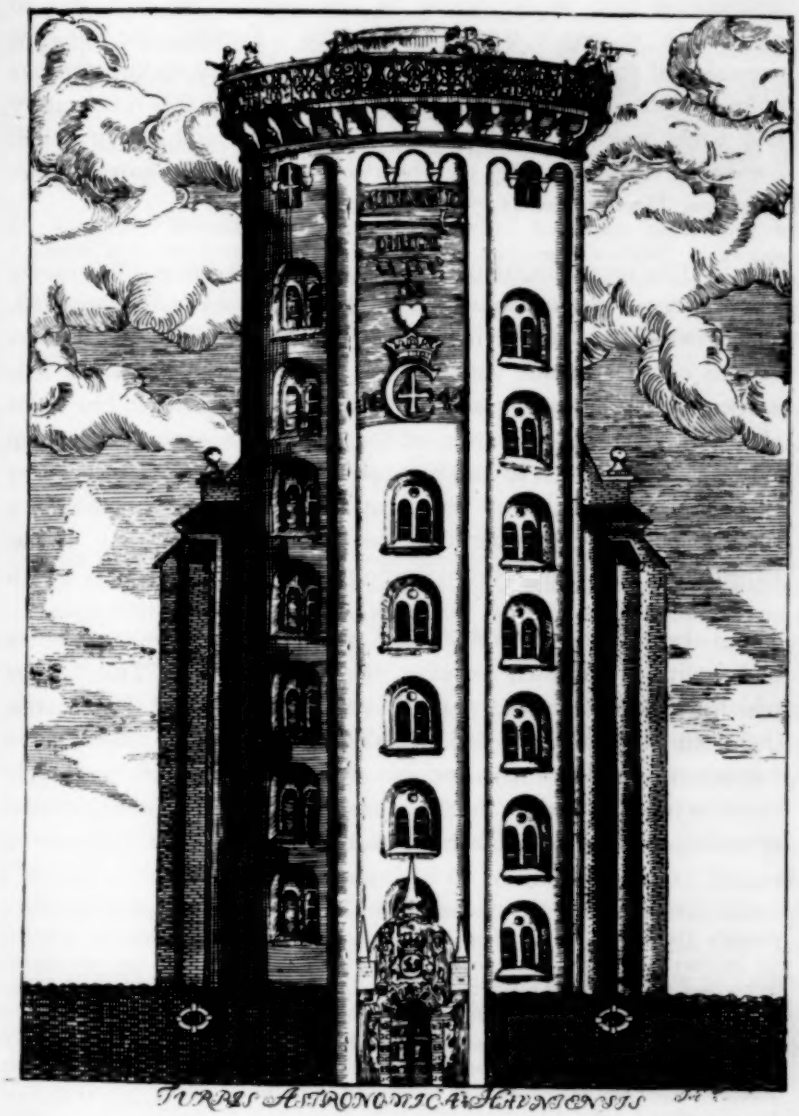

FIG. 2.

The " Round Tower " of Copenhagen
(frontispiece to HORREBOW's *Basis, etc.* see fig. 1.) See § 33.

this " Round Tower " but found it to be unsatisfactory, since instruments had to be placed on the unprotected roof and so were liable to severe wind disturbances. Further, the constant exposure of the unprotected observer was certain to be injurious to his health. ROEMER made plans for a more suitable observatory and while waiting for the details of approval and construction, converted his home into an observatory, the well-known *Observatorium Domesticum* (107).

34. The most distinguishing feature of this home observatory was the transit instrument which ROEMER designed and constructed, and of which he was the inventor. It was placed so that observations could be made with it at a window. Flexure of the axis was compensated for by a system of counterweights. The error of collimation (the deviation of the telescope's optical axis from a line perpendicular to the axis of rotation) was ascertained by the simple expedient of reversing the instrument. To ensure the telescope's being exactly in the plane of the meridian, it was adjusted by observing corresponding altitudes of the stars (108).

35. In order to obtain more perfect observations, ROEMER had built, at his own expense, the *Observatorium Tusculaneum* which was completed in 1704. It was located near Vridloesemagle (between Copenhagen and Roeskilde). Here, he installed an instrument similar to the one just described, but more accurately constructed. It had, at the common focus of the object-glass and eyepiece, a cross-web of horizontal and vertical wires, illuminated

(107) The *Observatorium Domesticum* is described in great detail by ROEMER's disciple HORREBOW in his *Basis*, etc., (see § 39 from which account GRANT, *op. cit.*, has gotten his information.) PETER HORREBOW (1679-1764), an astronomer in his own right, devoted much time and energy to perpetuating the master's ideas. Hence the *Basis*. Unfortunately, the pupil wrote the account from the master's fragments and seems not always to have fully understood what were ROEMER's ideas. For all that, this *Basis* remains the chief source for information concerning ROEMER's methods and ideas. Of HORREBOW, DELAMBRE (*op. cit.*, vol. II, p. 633) has remarked facetiously (or, viciously?), " A son tour il [ROEMER] eut un élève dans l'astronome HORREBOW, qui parait lui avoir voué une espèce de cutte." Cf. Note 116.

(108) The work of HORREBOW mentioned above, in addition to a description of the observatory, contains an account of the instruments and their use, as well as diagrams of their construction.

by a system of lenses and mirrors through an aperture in the side of the telescope. The instant of transit across an upright wire could be obtained by means of a clock loudly ticking on the wall by the observer. This instrument could be used either in the plane of the meridian or of the prime vertical. (See Pl. 3). Both here and in the *Observatorium Domesticum*, ROEMER used the instrument both ways.

Vers 1689, ROEMER construisit son instrument de passage qui pouvait être orienté, soit dans le méridien, soit dans le plan du premier vertical... dès ce temps l'Astronomie possède un instrument et une méthode permettant de déterminer d'une manière générale les déclinaisons par passages au lieu de hauteurs. D'ailleurs la méthode n'a guère été employée et tomba bientôt dans l'oubli, jusqu'à ce que BESSEL la fit revivre en 1824 (109).

Indeed, astronomers continued to measure celestial angles by the use of complicated and cumbersome instruments, oftentimes requiring many assistants for each detail of the operation. BESSEL, in describing his own work says

Was diesen Vorschlage für Sie noch mehr Interesse geben muss, ist, dass Ihr hochberümter Landsmann OLAUS ROEMER, der in seinen Ideen über astronomische Beobachtungen und Instrumente, selbst den Späteren so oft und bedeutend voreilte, bereits vor 120 Jahren ein Passagen-Instrument von Osten nach Westen aufgestellt hat;... (110).

It should be noted that BRADLEY introduced a sort of transit instrument into England (Greenwich) although the use of the quadrant for declinations, etc. continued until this reinvention by BESSEL of ROEMER's instrument (111).

In the *Observatorium Tusculaneum*, the error of collimation was at first determined by the method of reversal, but later ROEMER adopted the simpler method of observing two marks on the distant horizon, diametrically opposite each other. ROEMER also used an altazimuth telescope for the observation of corresponding altitudes of the sun and stars in order to regulate the clock and to adjust the positions of the meridian instruments. Another telescope

(109) HUYGENS : *Œuvres* (S.H.) Vol. XV., p. 521.

(110) Ueber d. Bestimmungd. Polhöhenunterschiede durch das Passageninstrument. Auszug aus einem Briefe des Herrn Professors und Ritters BESSEL an den Herausgeber (February 2, 1824); *Astronomische Nachrichten (herausgegeben von* H. C. SCHUMACHER), Vol. III, 1825, pp. 10-14. BESSEL appears to refer to the ROEMER letter mentioned in Note 117.

(111) See DOBERCK, § 39.

which he designed for himself was a meridian, or transit circle. (I believe ROEMER was the first person to attach a telescope to the altazimuth and circle.)

Last, but by no means least, of the complement of instruments was an equatorially mounted instrument which ROEMER designed in order to be able to follow a celestial body through all of its course above the horizon, just as we do today. He also made use of this instrument in the measurement of the differences in right ascension and declination of two stars very close together (112).

36. ROEMER's observational methods and many of his calculations were entered into his commonplace book. This book (or portfolio of notes) was deposited by his window in the library of the University of Copenhagen in 1739. On the cover, ROEMER had inscribed the title, *Adversaria* (113). Among the methods described therein which have been attributed to other astronomers, we mention but two : the MAYER formulae [published in 1775 by TOBIAS MAYER (1723-1762) and used by him to correct his observations on the mural quadrant at Göttingen] and the HORREBOW-TALCOTT method of determining latitudes (114).

ROEMER made many observations which he deposited in Copenhagen, only to have them completely destroyed after his death by the great fire of 1728 (115). The only observations which

(112) According to HORREBOW, *op. cit.*, some catastrophe overtook the *Observatorium Tusculaneum*, destroying the instruments completely, but the nature of this is not stated clearly.

(113) These were found at the beginning of this century. They were published as OLE RØMERS *Adversaria, med Uderstøttelse af Carlsbergfondet udgivne af det Kongelige Danske Videnskabernes Selskab ved* THYRA EIBE *og* KIRSTINE MEYER, Copenhagen, 1910. See in this regard, the " crowned " memoir by G. VAN BIESBROECK and ALB. TIBERGHIEN : Études sur les notes astronomiques contenues dans les Adversaria d'OLE RØMER; *Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger*, 1913, pp. 213-24. It is arranged by subject and has a table of contents at the end; a necessary guide to the study of the *Adversaria*. In a note at the beginning of the *Oversigt* for 1913, *Rapport sur un mémoire traitant la question d'Astronomie mise au concours en* 1911, there are some criticisms of this " crowned " memoir and it is also here mentioned that the introduction of the Gregorian calendar was not in 1710, after ROEMER's death, but in 1700.

(114) See G. VAN BIESBROECK : Les travaux astronomiques d'OLAUS ROEMER; *Ciel et Terre (Bulletin de la Société Belge d'Astronomie)* Vol. XXXIV, 1913, pp. 152-67.

(115) This fire is described very dramatically by HORREBOW, *op. cit.*

have survived (in addition to those scattered throughout *Adversaria*) are those which he called the *Triduum* (116). These consist of a list of the declinations and right ascensions of certain stars, determined with the meridian circle on three successive nights in October of 1706. These escaped destruction as Roemer, intending them to serve as illustrations of the superiority of his methods of observing, had sent out copies to different astronomers.

37. In a letter written to LEIBNIZ, dated December 15, 1700, in reply to LEIBNIZ's request for the most suitable plan for an observatory, ROEMER describes his plans for the *Observatorium Tusculaneum*. He has an excellent discussion of the need of building the observatory so that it can best serve the function for which it is intended, namely, observation. He probably was thinking of the construction of the Paris Observatory, a beautiful building, but impractical as far as actual observational needs were concerned. He also describes the prime vertical transit and (117) states his preference for the circle as compared to quadrants and sextants, saying that he would have more confidence in a circle of four feet in diameter than in a quadrant of ten (118).

(116) These observations are to be found in HORREBOW's *Basis* and they are the subject of a doctoral dissertation by JOHANN GOTTFRIED GALLE (1812-1910) who, using the elements sent to him by LE VERRIER, was the first person to see the planet Neptune (1846). This *dissertatio inauguralis*, Berlin, 1845, indicates that ROEMER's observations were clearly superior to any made by his contemporaries. It is entitled *Olai Roemeri triduum observationum astronomicarum* A.MDCCVI *diebus* M. *Oct.* XX *usque ad* XXIII. *institutarum, reductum et cum tabulis comparatum.*

GRANT, *op. cit.*, p. 465, could say in 1851 of these that "in accuracy they are surpassed only in a slight degree by the observations of the present day" and DELAMBRE, *op. cit.*, p. 661, remarks that "si les observations de ROEMER avaient toutes la même précision que celles du *triduum*, leur perte a été une calamité pour l'Astronomie." This is doubly important, for DELAMBRE states that ROEMER "n'est pour nous que l'élève et l'ami de PICARD." He seems purposely to misquote HORREBOW's *Basis* and to confuse the *Observatorium Domesticum* with the *Observatorium Tusculanum*. Thus DELAMBRE, who was in an admirable position to evaluate ROEMER's practical work, gives an account that is almost completely worthless. Cf. GRANT, *op. cit.*, p. 462-65.

(117) Olai Roemeri ad G. G. Leibnitium epistola de instrumento astronomicis observationibus serviente a se inventa; *Miscellanea Berolinensia*, Vol. III, 1727, pp. 276-78.

(118) ROEMER became a member of the Berlin Academy ("Auswärtiges Mitglied") on December 30, 1701. In addition to the paper mentioned in Note

38. ROEMER was twice married : in 1681 to ANNE MARIA BARTHOLIN (the daughter of ERASMUS BARTHOLIN) and after her death in 1694, to ELISA MAGDALENA BARTHOLIN (the daughter of CASPAR BARTHOLIN, Regius professor of philosophy in the University of Copenhagen) in 1698. He did not survive his second wife and died without issue at the age of 65 on September 19, 1710 of a " tortor calculus."

ROEMER was too modest to demand for himself any glory or praise from his contemporaries; he was too busy to be able to devote any of his time to the spreading of his ideas. Calamity seems to have conspired with fate to prevent the dissemination of his work after his death so that ROEMER, considered by his contemporary scientists to be one of the leading figures of his age, is today known generally only because of his discovery of " mora luminis " and for the first determination of the velocity of light (119).

Carnegie Institution. I BERNARD COHEN.

117, he published in the *Miscellanea Berolinensia*, Vol. I 1710, pp. 131-33, a paper entitled " Descriptio luminis borealis, quod nocte inter 1. et 2. Februarii 1707. Hafniae visum est."

(119) *Supplementary note.*—Although it is certain that BEECKMAN believed that the velocity of light was finite, it appears not so certain that it was to him that DESCARTES wrote the letter discussed in § 8. BEECKMAN's journal will be published in the fall by MARTINUS NIJHOFF and this will perhaps throw more light on the question, since the only data we have are the excerpts partially quoted in § 8, from the ADAM and TANNERY edition of DESCARTES. Although TANNERY deduced that DESCARTES' correspondent was BEECKMAN, his collaborator, ADAM, seems not to agree; in Vol. I of his recent edition (with G. MILHAUD) of the correspondence of DESCARTES, Paris 1936, the letter (no. 66, pp. 267-274) bears the superscription —" DECARTES à BEECKMAN ou HORTENSIUS ? " No reason is given for this.

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40. The portrait of ROEMER which forms the frontispiece to this article was obtained through the kindness of Dr. SIGFÚS BLÖNDAL of the Royal Library of Copenhagen. The original painting, which was made by one of ROEMER's contemporaries, is at present in the astronomical museum of the Round Tower (see Pl. 3; § 33) which was founded by its present curator, Mr. HARALD MORTENSEN. It is through Mr. MORTENSEN's courtesy that we are able to reproduce it here.

41. The first two following facsimiles are here reproduced through the courtesy of the HARVARD LIBRARY. The first (xix), " Demonstration touchant le mouvement de la lumiere," is taken from the *Journal des Sçavans*, " du Lundy 7 Decembre M.DC. LXXVI." There was a later printing of the volumes of the *Journal des Sçavans* in which this article appeared, but we have here reproduced the first printing. It also appeared in *Anc. Mém.* Vol. X, pp. 575-76, in the section called " Memoires de mathématiques et de physique par messieurs de l'Académie Royale des Sciences. Extraits des Journaux des Sçavans." Facsimile xx, " Demonstration concerning the motion of light," a translation of the first facsimile, appeared in the *Philosophical Transactions*, Vol. XII, June 25, 1677, pp. 893-94. The third facsimile, (xxi), a quarter of the ROEMER manuscript, is reproduced through the courtesy of the DANISH ROYAL ACADEMY OF SCIENCES; for description, see § 21 and note 78.

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de Salvio, 15n.
de Sitter, 100n.
Doberck, 111n, 39.
Dreyer, 42n.
du Hamel, 38n, 54n, 15, 79n.
Eibe, 113n.
Ellis, 9n.
Empedocles, 3.
Euclid, 12n.
Fahrenheit, 32, 39.
Fermat, 15.
Flamsteed, 14, 26, 27.
Fontenelle, 38n, 42n, 20.
Foulques, 6n.
Frederick IV, 30, 31.
Friend, 39.
Galileo, 7, 26n, 11.
Galle, 116n, 39.
Glasenap, 29.
Grant, 35n, 36n, 68n, 116n, 39.
Halley, 14, 68n, 26, 27, 28.
Harding, 39.
Hero, 3.
Hipparchus, 12.
Hodierna, 36n.
Hooke, 10, 84n.
Horrebow, 107n, 108n, 112n, 36, 39.
Huygens, 24n, 25n, 11, 14, 15, 19, 20, 21, 22, 26, 29.
ibn al-Haitham, see Alhazen.
ibn Sînâ, see Avicenna.
Jebb, 6n.
Kepler, 6.
la Hire, 14, 26.
Laplace, 102n.
Leibniz, 14, 37.
le Monnier, 50n, 15, 24.
le Verrier, 116n.
Longomontanus, 33.
Louis XIV, 11, 14, 15.
Maindron, 49n.
Maraldi, J. P., 16, 20.
Maraldi, J. D., 28.
Maury, 32n.
Mayer, S., 36n.
Mayer, T., 36.
Medici, 17n.
Meisen, 39.
Mersenne, 9.
Meyer, 1, 78n, 105n, 24, 39.
Molyneux, 25.
Montucla, 46n, 49n, 39.
Mortensen, 39, 40.
Musschenbroeck, v., 18n.
Newton, 14, 24, 25.
Nielsen, 39.
Nix, 2n.
Pelseneer, 30n.
Pepys, 85n.
Philipsen, 39.
Picard, 11, 12, 13, 14, 15, 21, 116n.
Poggendorff, 39.
Ptolemy, 12n, 12.
Priestley, 5n.
Prytz, 39.
Risner, 4n, 12n.
Robertson, 9n.
Roemer, Ole, *passim*.
Roemer, C. O., 13.
Ross, 1n.
Salmonsen, 39.
Sampson, 29.
Sarton, 3n, 95n.
Schmidt, 2n.
Schroeter, 2n.
Schumacher, 110n.
See, 102n, 39.
Spedding, 9n.
Spole, 31.
Stormia, 13.
Tannery, 21n, 119n.
Tiberghien, 113n, 39.

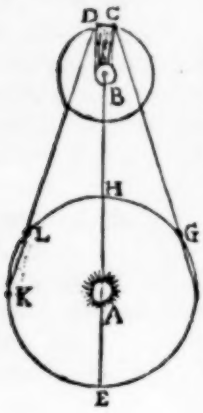
TYCHO, 12, 13, 33.
VITELLIUS, 6.
WALLER, 18n, 84n.
WERNICKE, 77n, 39.
WHITTAKER, 29.
WITELO, see VITELLIUS.
WOLF, 60n.

FACSIMILE XIX

DEMONSTRATION TOVCHANT LE mouvemens de la lumiere trouvé par M. Römer de l'Academie Royale des Sciences.

IL y a long-temps que les Philoſophes ſont en peine de decider par quelque experience, ſi l'action de la lumiere ſe porte dans un inſtant à quelque diſtance que ce ſoit, ou ſi elle demande du temps. Mr Römer de l'Academie Royale des Sciences s'eſt aviſé d'un moyen tiré des obſervations du premier ſatellite de Jupiter, par lequel il démontre que pour une diſtance d'environ 3000 lieuës, telle qu'eſt à peu prés la grandeur du diametre de la terre, la lumiere n'a pas beſoin d'u-

ne ſeconde de temps.



Soit A le Soleil, B Jupiter, C le premier Satellite qui entre dans l'ombre de Jupiter pour en ſortir en D, & ſoit E F G H K L la Terre placée à diverſes diſtances de Jupiter.

Or ſuppoſé que la terre eſtant en L vers la ſeconde Quadrature de Jupiter, ait veu le premier Satellite, lors de ſon émerſion ou ſortie de l'ombre en D ; & qu'en ſuite environ 42. heures & demie aprés, ſçavoir aprés une revolution de ce Satellite, la terre ſe trouvant en K, le voye de retour en D : Il eſt manifeſte que ſi la lumiere demande du temps pour traverſer l'intervalle L K, le Satellite ſera veu plus tard de retour en D, qu'il n'auroit eſté ſi la terre eſtoit demeurée en K, de ſorte que la revolution de ce Satellite, ainſi obſervée par les Emerſions, ſera retardée d'autant de temps que la lumiere en aura employé à paſſer de L en K, & qu'au contraire dans l'autre Quadrature F G, où la terre en s'approchant, va au devant de la lumiere, les revolutions des Immerſions paroiſtront autant accourcies, que celles des Emerſions avoient paru alongées. Et parce qu'en 42 heures & demy, que le Satellite employe à peu prés à faire chaque revolution, la diſtance entre la Terre & Iupiter dans l'un & l'autre Quadrature varie tout au moins de 210. diametres de la

Terre, il s'enſuit que ſi pour la valeur de chaque diametre de la Terre, il faloit une ſeconde de temps, la lumiere employeroit 3 ½ min. pour chacũ des intervalles GF, KL, ce qui cauſeroit une differẽce de prés d'un demy quart d'heure entre deux revolutions du premier Satellite, dont l'une auroit eſte obſervée en FG, & l'autre en KL, au lieu qu'on n'y remarque aucune difference ſenſible.

Il ne s'enſuit pas pourtant que la lumiere ne demande aucun temps : car apres avoir examinè la choſe de plus prés, il a trouvé que ce qui n'étoit pas ſenſible en deux revolutions, devenoit tres-conſiderable à l'égard de pluſieurs priſes enſemble, & que par exemple 40 revolutions obſervées du coſté F, eſtoient ſenſiblement plus courtes, que 40. autres obſervées de l'autre côté en quelque endroit du Zodiaque que Iupiter ſe ſoit rencontré ; & ce à raiſon de 22 pour tout l'intervalle H E, qui eſt le double de celuy qu'il y a d'icy au ſoleil.

La neceſſité de cette nouvelle Equation du retardement de la lumiere, eſt établie par toutes les obſervations qui ont eſté faites à l'Academie Royale, & à l Obſervatoire depuis 8. ans, & nouvellement elle a eſté confirmée par l'Emerſion du premier Satellite obſervée à Paris le 9. Novembre dernier à 5. h. 35.′ 45.″ du ſoir, 10. minutes plus tard qu'on ne l'eût deû attendre, en la déduiſant de celles qui avoient eſté obſervées au mois d'Aouſt, lors que la terre eſtoit beaucoup plus proche de Iupiter ; ce que Mr Romer avoit predit à l'Acade-

mie dés le commencement de Septembre.

Mais pour oſter tout lieu de douter que cette inégalité ſoit cauſée par le retardement de la lumiere, il demontre qu'elle ne peut venir d'aucune excentricité, ou autre cauſe de celles qu'on apporte ordinairement, pour expliquer les irregularitez de la Lune & des autres Planetes : bien que neanmoins il ſe ſoit aperceu que le premier Satellite de Iupiter eſtoit excentrique, & que dailleurs ſes revolutions eſtoient avancées ou retardées à meſure que Iupiter s'aprochoit ou s'éloignoit du ſoleil, & même que les revolutions du premier Mobile eſtoient inégales ; ſans toutesfois que ces trois dernieres cauſes d'inégalité empêchent que la premiere ne ſoit manifeſte.

FACSIMILE XX

(893)

A Demonſtration concerning the Motion of Light, *communicated from* Paris, *in the* Journal des Scavans, *and here made Engliſh.*

PHiloſophers have been labouring for many years to decide by ſome Experience, whether the action of Light be conveyed in an inſtance to diſtant places, or whether it requireth time. M. *Romer* of the *R. Academy* of the Sciences hath deviſed a way, taken from the Obſervations of the firſt Satellit of *Jupiter*, by which he demonſtrates, that for the diſtance of about 3000 leagues, ſuch as is very near the bigneſs of the Diameter of the Earth, Light needs not one ſecond of time.

Let (in *Fig.* 11.) A be the *Sun*, B *Jupiter*, C the firſt Satellit of *Jupiter*, which enters into the ſhadow of *Jupiter*, to come out of it at D; and let EFGHKL be the *Earth* placed at divers diſtances from *Jupiter*.

Now, ſuppoſe the *Earth*, being in L towards the ſecond Quadrature of *Jupiter*, hath ſeen the firſt Satellit at the time of its emerſion or iſſuing out of the ſhadow in D; and that about 42½ hours after, (*viz.* after one revolution of this Satellit,) the *Earth* being in K, do ſee it returned in D; it is manifeſt, that if the Light require time to traverſe the interval LK, the Satellit will be ſeen returned later in D, than it would have been if the Earth had remained in L, ſo that the revolution of this Satellit being thus obſerved by the Emerſions, will be retarded by ſo much time, as the Light ſhall have taken in paſſing from L to K, and that, on the contrary, in the other Quadrature FG, where the *Earth* by approaching goes to meet the Light, the revolutions of the Immerſions will appear to be ſhortned by ſo much, as thoſe of the Emerſions had appeared to be lengthned. And becauſe in 42½ hours, which this Satellit very near takes to make one revolution, the diſtance between the *Earth* and *Jupiter* in both the Quadratures varies at leaſt 210 Diameters of the *Earth*, it follows, that if for the account of every Diameter of the *Earth* there were required a ſecond of time, the Light would take 3½ minutes for each of the intervals GF, KL; which would cauſe near half a quarter of an hour between two revolutions of the firſt Satellit, one obſerved in FG, and the other in KL, whereas there is not obſerved any ſenſible difference.

Yet

Yet doth it not follow hence, that Light demands no time. For, after M. *Romer* had examin'd the thing more nearly, he found, that what was not ſenſible in two revolutions, became very conſiderable in many being taken together, and that, for example, forty revolutions obſerved on the ſide F, might be ſenſibly ſhorter, than forty others obſerved in any place of the Zodiack where *Jupiter* may be met with; and that in proportion of twenty two for the whole interval of H E, which is the double of the interval that is from hence to the Sun.

The neceſſity of this new Equation of the retardment of Light, is eſtabliſhed by all the obſervations that have been made in the *R. Academy*, and in the *Obſervatory*, for the ſpace of eight years, and it hath been lately confirmed by the Emerſion of the firſt Satellit obſerved at *Paris* the 9*th* of *November* laſt at 5 a Clock, 35'. 45". at Night, 10 minutes later than it was to be expected, by deducing it from thoſe that had been obſerved in the Month of *Auguſt*, when the *Earth* was much nearer to *Jupiter*: Which M. *Romer* had predicted to the ſaid Academy from the beginning of *September*.

But to remove all doubt, that this inequality is cauſed by the retardment of the Light, he demonſtrates, that it cannot come from any excentricity, or any other cauſe of thoſe that are commonly alledged to explicate the irregularities of the *Moon* and the other Planets; though he be well aware, that the firſt Satellit of *Jupiter* was excentrick, and that, beſides, his revolutions were advanced or retarded according as *Jupiter* did approach to or recede from the Sun, as alſo that the revolutions of the *primum mobile* were unequal; yet ſaith he, theſe three laſt cauſes of inequality do not hinder the firſt from being manifeſt.

FACSIMILE XXI

Some Remarks on the Diagnosis and Treatment of Tuberculosis in Antiquity (*)

Phthisis is defined by GALEN (1) as an ulceration of the lungs, chest, or throat, accompanied by coughs, low fevers, and wasting of the body because of pus. But he also remarks that, in another sense, *phthisis* may be a more general name for all bodily wasting, and *phthoë* the consuming of the body by an ulceration. In another place (2) he says it may be caused by blood escaping into the lungs or between the lungs and chest and putrifying. But he also says (3) that HIPPOCRATES thought it was caused by a noxious humor flowing from the head to the throat and lungs. Elsewhere (4) GALEN describes it as a disease of malnutrition. Some of these divergent views he summarizes in another passage (5) into two main types : (*a*) that due to defluxions from the head, and (*b*) that arising not from the head but in the lungs, from such causes as ulcers, breaking of blood-vessels, etc. In the second century after Christ ARETAEUS (6) says : " If from an abscess in the lung or a settled cough or spitting of blood, pus should develop within and the patient should spit it out, the disease is called *pyë* and *phthisis*. But if the chest or a rib suppurates and pus comes out through the lungs it is called *empyë*. If, after this, the lung, consumed by the passage of the pus, has an abscess, it is called *phthoë*.

(*) Read at a Medical Colloquium at the Harvard Medical School, 19 January, 1939.

(1) XIX, 419; cf. XIV, 744; XVII B, 796 (after HIPPOCRATES); ISID. *Etym.* 4, 7, 17. GALEN is here cited by the volumes and pages of KÜHN's edition (1821-1833).

(2) V, 679.

(3) XVII A, 663; cf. VI, 421.

(4) VII, 63.

(5) XVII A, 61.

(6) *Sign. diut. Morb.* 1, 8.

In Greek the verbs used to describe the disease are *phthio* or *phthino*, from which are derived the nouns *phthisis* and *phthoë* and the adjectives *phthisikos* and *phthinodes*. Analogous to our abbreviation 'TB' is the use by HIPPOCRATES for this disease of the Greek letter *Φ* (7). (Sometimes the verbs *tekomai* or *marainomai* (8) are used for *phthino*.) In Latin the native noun is *tabes* (9) ('wasting'), but *phthisis* is often used. *Consumptio* is perhaps used in this sense in the fifth century by CASSIUS FELIX, and certainly by ISIDORE in the seventh century (10). Frequently, of course, other phrases, especially words for coughs, may have tuberculous implications. Thus MARTIAL (11), in an epigram on a legacy-hunter, writes: "Gemellus is courting Maronilla, and he desires and urges and entreats and gives presents." "Is she so handsome?" "On the contrary nothing is uglier." "What then in her is sought and gives satisfaction?" "She has a cough" *(tussit)*. HORACE also (12), when he links *tussis* (coughing) with pleurisy and gout and poisons and wounds, probably had in mind a chronic and serious disease, while in other authors the phrase *veteres tusses* (13) (settled coughs) suggests the same. In my present remarks I shall, to avoid anachronism, use the terms 'phthisis' and 'consumption' rather than 'tuberculosis,' which rests upon a conception of the disease unknown in antiquity.

Phthisis is described by GALEN as a chronic disease (14), difficult or impossible of cure (15). ARETAEUS (16) is somewhat less pessimistic, but S. AUGUSTINE (17)—doubtless reflecting the popular thought about this disease—, says "Who can cure it? He must perish, he must die," and LUCIAN (18) mentions among roads to death lightning, the sword, fever, and phthoë. I might

(7) Cf. GALEN, XVII A, 613.
(8) GALEN, XVI, 552.
(9) CELS. 2, 1, 8. The adjective is *tabidus*, the verb *tabesco*.
(10) *Etym.* 4, 7, 17.
(11) 1,10.
(12) *Serm.* 1, 9, 32.
(13) E.g., COLUM. 12, 33; MARC. EMP. 14, 70; ISID. *Etym.* 4, 6, 1; 4, 7, 1.
(14) GALEN, XVII B, 385; SEREN. SAMMON. *Lib. medic.* 341 calls it *annoso morbo*.
(15) GALEN, XIV, 744.
(16) *Sign. diut. Morb.* 1, 8.
(17) *Serm.* 77, 14.
(18) *Iup. Trag.* 25.

also, in passing, mention a legal aspect of the question. PLATO, in the *Laws* (19), remarks : " If a man sell a slave who is suffering from phthisis or stone or strangury or epilepsy or any other complaint, mental or physical, which most men would fail to notice, though it be prolonged and hard to cure—in case the purchaser be a doctor or a trainer it shall not be possible for him to gain restitution, nor yet if the seller warned the purchaser of the facts. But if any professional person sell any such slave to a lay person the buyer shall claim restitution within six months, except for epilepsy, for which disease he may claim within twelve months. The action shall be before a bench of physicians nominated or chosen by both parties, and the party losing his case shall pay double the selling price of the slave " (20).

HIPPOCRATES (21) states that phthisis occurs chiefly between the ages of 18 and 35 years, and other writers, such as GALEN (22), CELSUS (23), ARETAEUS (24), and ISISDORE (25), associate it with *adulescentes* or *iuvenes*, i.e., youth or early middle age. Localities predisposing to the disease were, according to HIPPOCRATES (26), those near marshy, stagnant waters, or according to ARETAEUS (27), cold, damp regions. The Roman architect, VITRUVIUS (28), warns in this connection against places subject to winds, which are also unfavorable to catarrh, hoarseness, coughs, pleurisy, and all diseases which are cured not by lowering the system but by building it up, and GALEN (29) declares that it is hard to cure phthisis in windy localities. VITRUVIUS continues that these maladies are in general hard to cure, (1) because they are originally due to chills; (2) because the patient's system being already exhausted by disease, the air there, which is in constant agitation owing to winds, and therefore deteriorated, takes all the sap out of their diseased bodies and leaves them more meagre every

(19) 11, 916 A.
(20) Cf. GELL. 4, 2, 4 for a Roman parallel.
(21) *Aphor.* 5, 9; followed by GALEN, XVII B, 794.
(22) V, 695; XVII B, 642.
(23) 2, 1, 21.
(24) *Sign. diut. Morb.* 1, 8.
(25) *Etym.* 4, 7, 17.
(26) *Aër.* 7.
(27) *L. c.*
(28) 1, 6, 3.
(29) XVI, 399; cf. XVII A, 719.

day. On the other hand, a mild, thick air, without draughts and not constantly blowing back and forth, builds up their frames by its unwavering steadiness, and so strengthens and restores those affected by these diseases.

As between different seasons HIPPOCRATES (30) observed that a dry summer, with north winds, followed by an autumn wet and with south winds, leads to a winter in which there are prevalent headaches, coughs, sore throats, colds in the head, and in some cases consumption. This opinion is echoed by CELSUS (31), and the Pseudo-Aristotelian *Problemata* (32) offer the explanation that "the winter finds a considerable amount of matter in the body and so it is a difficult task for it to solidify the moisture and form phlegm. Consequently, when moisture is engendered in the head it causes a feeling of heaviness, and if it is plenteous and cold it causes mortification, but if, owing to its abundance, it does not solidify, it flows into the nearest regions of the body, and thus coughs are caused and sore throats and wasting," ARETAEUS (33) also remarks that inflammations arise chiefly in summer and consumptions especially in autumn. The emphasis on dryness or drought (34) as a precursor suggests to a layman that inflammation due to dust—to which Mediterranean lands are particularly subject—may have been a significant factor, though coldness and changeability of weather also appear as elements (35).

The contagious character of phthisis is recognized in the Pseudo-Aristotelian *Problemata* (36), where it is suggested that it is carried, like plague, by the breath, and GALEN (37) declares it to be dangerous to associate with those affected by *phthoë*, and all persons whose breath is so putrid as to render malodorous the houses in which they lie ill. That a consumptive parent may have a consumptive child was remarked by HIPPOCRATES (38),

(30) *Aphor.* 3, 13; *Aër.* 10; cf. *Epidem.* 3, 2; also SEN. *Ep.* 91, 5; GALEN, XVII B, 590.

(31) 2, 1, 15.

(32) 1,10.

(33) *Sign. acut. Morb.* 2, 2. On the incidence of phthisis in autumn see also CELS. 2, 8, 24; GALEN, V, 694; XVI, 27; XVII A, 719; XVII B, 577.

(34) HIPPOCR. *Aphor.* 3, 13.

(35) GALEN, XVII A, 33; XVII B, 622.

(36) 7, 8.

(37) VII, 279.

(38) *Morb. Sacr.* 5.

and PLUTARCH (39) asks why it is customary to bid the children of those who die of phthisis or dropsy to sit with their feet in water while the corpse is being burned, and concludes that it is in order to prevent the disease from approaching or being transferred to them. That phthisis might follow as a complication after other maladies is rather often noted, especially after settled coughs (40), fevers (particularly quartan fevers) (41), haemorrhoids, (42) and other losses of blood (43), pleurisy (44), poisoning (45), sweating, sleeplessness, and extreme fatigue. In the case of the last named the satirist LUCIAN remarks (46) : "In your case the diet is in contrast to your former way of living; the sleeplessness too and the sweating and weariness gradually undermine you, giving rise to consumption, pneumonia, indigestion, and that noble complaint, the gout." According to HIPPOCRATES (47), cases of phthisis are frequent after parturition, the violence of which causes ruptures and strains; also after any suppression of the regular menstrual flow (48). In its turn a consumptive condition also opened the door for other diseases, such as dropsy (49) and quintan fever (50), and HIPPOCRATES (51) describes an epidemic at Thasos in which consumptives were the first to be attacked, the only ones who died, and the victims of a high rate of mortality.

Foremost among symptoms is the thinness of the patient (52),

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(39) *De Sera Num. Vind.* 14.

(40) SEN. *Ep.* 75, 12; 78, 1-5.

(41) HIPPOCR. *Epid.* 1, 24; GALEN, VII, 470.

(42) HIPPOCR. *Aphor.* 6, 12 (suggesting that in the cure of chronic haemorrhoids it is wise to leave one, lest dropsy or phthisis supervene; cf. GALEN, XVIII A, 22); GALEN, XVI, 455; 795; XVIII A, 21; CELS. 2, 7, 19.

(43) HEROD. 7, 88 describes a wound following by vomiting of blood and then by phthisis (cf. PLUT. *Cleom.* 30, 1, of King ANTIGONUS); DIO CASS. 69, 20 (of the Emperor HADRIAN).

(44) HIPPOCR. *Aphor.* 5, 8; GALEN, XVII B, 799.

(45) PLUT. *Arat.* 52, 2-3.

(46) *De Merc. Cond.* 31.

(47) *Aër.* 4.

(48) HIPPOCR. *Praedict.* 2, p. 199 KÜHN.

(49) DIO CASS. 69, 20.

(50) GALEN, XVII A, 240.

(51) *Epid.* 1, 2-5.

(52) VITRUV. 1, 6, 3; SEN. *Ep.* 78, 1, EPICTET. 3, 22, 86 (who remarks that a consumptive carries little weight in public deliberations); GALEN, XVI, 552; CASSIOD. *Var.* 11, 10, 1.

persons of meagre habit being most liable to the disease (53), particularly those whose shoulder-blades project like wings, to whom was applied the adjective *pterygodeis* (54). In fact, much of the treatment aimed at fattening the consumptive, for HIPPOCRATES (55) observes that in this disease it is not an advantage to be thin, and the patient must be built up so as to come out from it as stout as possible. Paleness is also noteworthy (56), the skin being described by HIPPOCRATES (57) as smooth, whitish, lentil-colored, or reddish (GALEN (58) also mentions red cheeks). The hair, according to ARISTOTLE (59), grows faster than normally, but also, as the disease approaches a mortal stage and nutrition fails it falls out noticeably (60). The eyes appear hollow (61) and—if HIPPOCRATES (62) be correctly interpreted—unnaturally bright; the flesh falls away from the nails and leaves them hooked in shape (63). Discharges occur from the various openings of the body; from the nose, of mucus (64) or of blood (65); elsewhere diarrhoea (66)—particularly affecting those of a bilious temperament—, urine with cobwebby sediment (67), seminal losses during sleep (68), and, most significant, expectoration, of blood (69), and, later, of pus, the color and consistency of which are to be carefully noted. " In pulmonary disease," remarks CELSUS (70), following HIPPOCRATES (71), " if there was no expectoration during

(53) CELS. 2, 1, 23; ARETAEUS 1, 8.
(54) HIPPOCR. *Epid.* 3, 14; GALEN, XVII B, 53.
(55) *De intern. Affect.*, p. 429 KÜHN.
(56) EPICTET. 3, 22, 86; ARETAEUS, *Sign. diut. Morb.* 1, 8.
(57) *Epid.* 3, 14.
(58) XVIII B, 203.
(59) *Hist. An.* 3, 2; cf. *De Gen. An.* 2, 6.
(60) HIPPOCR. *De Morb.* 2, p. 260 KÜHN; *Aphor.* 5, 12; CELS. 2, 8, 24; GALEN, XVII B, 796-799.
(61) GALEN, XVIII B, 203.
(62) *Epid.* 3, 14.
(63) GALEN, VIII, 47; XVI, 205; XVIII B, 201; 204.
(64) I so interpret CELS. 2, 7, 28.
(65) DIO CASS. 69, 17.
(66) HIPPOCR. *Epid.* 3, 14; CELS. 2, 8, 22; GALEN, XVII B, 796-799.
(67) CELS. 2, 8, 24.
(68) PS.-ARIST. *Probl.* 5, 31.
(69) CELS. 2, 7, 16.
(70) 2, 8, 22.
(71) *Prognost.* 15; cf. *Epid.* 3, 13.

the first days, if it begins from the seventh day and persists beyond a further seven days it is dangerous. And the more the sputum has an indistinguishable admixture of colors, the worse it is. But nevertheless nothing is worse than for the expectoration emitted to be homogeneous, whether reddish, or clotted, or white, or glutinous, or pallid, or frothy; worst of all, however, is the black." If the sputum when thrown on live coals yields a bad odor, death is at hand, says HIPPOCRATES (72), and when spitting ceases the patients die, from inability to purge the lungs, since the passages of the breath are choked (73). The deadly sequence, according to GALEN (74), is spitting of blood, spitting of pus, phthisis, and death. Other symptoms are sleeplessness (75), fever (76), and accompanying lack of appetite (77). Cravings of various sorts are mentioned, and PLUTARCH (78) reports Dr. MNESITHEUS as saying that at the beginning of pulmonary disease a longing for onions indicates eventual recovery, while that for figs is a prognostic of death. So well known and obvious were some of these symptoms that the consumptive could usually, we are told, be recognized even by a layman (79), though the sight of one so affected is said by PLUTARCH (80) to have been generally regarded as unpleasant. The kinds of dreams portending the oncoming of the disease, described in two places by ARTEMIDORUS (81), belong to the history of symbolic dream-interpretation rather than to medical prognosis.

That phthisis is a disease not only of men but also of cattle was recognized by the agricultural writer COLUMELLA (82), who states that ulcers of the lungs are followed by coughing, wasting *(macies)*, and, finally, phthisis.

(72) *De Morb.* 2, p. 260 KÜHN; *Aphor.* 5, 12; GALEN, XVII B, 796. This seems like a form of empyromancy, for which cf. A. BOUCHÉ-LECLERCQ, *Hist. de la Divination dans l'Antiquité*, 1 (1879), 179.

(73) GALEN, XVIII A, 116.

(74) XIV, 743.

(75) ARET. *Sign. diut. Morb.* 1, 8.

(76) HIPPOCR. *Prognost.* 16; *Epid.* 3, 13; CELS. 2, 8, 24.

(77) HIPPOCR. *Epid.* 3, 13; CELS. 2, 8, 23.

(78) *Aet. phys.* 2, 6.

(79) GALEN, XVI, 552; ARET. *Sign. diut. Morb.* 1, 8.

(80) *Quaest. conv.* 5, 1, 2.

(81) 1, 21; 1, 31.

(82) 6, 14. Should we compare VIRG. *Ecl.* 3,100? Probably not; cf. *Aen.* 6,442.

Passing to methods of cure I may first remark that certain types of locality were considered most favorable for this. PLINY (83) says that woods from which pitch and resin are gathered (i.e., fir or larch woods) are especially helpful for consumptives or for those who because of continued illness have not recovered their strength, the air of such woods being even more beneficial than a voyage to Egypt or drinking milk in the summer in the mountains. When one reflects that in Italy these trees are found at considerable altitudes (84), in regions where agriculture and the dust arising from tillage are at a minimum (85), in a bracing air, where extremes of temperature are less than at higher or lower levels, and where swamps and dampness are infrequent, he can see reason for the prescription, apart from any virtues in the trees themselves. For those who could not go so far, a nearer set of resorts was found especially near the Bay of Naples, which seems to have been for the Romans somewhat like what Atlantic City or Cape May is for our northern states. HIPPOCRATES (86) had mentioned baths as better for pulmonary inflammations than for fevers, and SIDONIUS (87), in the fifth century after Christ, describes warm baths at Baiae as relieving those with liver complaints or weak from the beginnings of phthisis (88). Yet more than three centuries earlier the Emperor HADRIAN, as his biographer SPARTIANUS (89) reports, had received no benefit there; perhaps because his disease was already too far advanced. To Forum Iulium, the modern Fréjus, near Nice, the Younger PLINY (90) proposed to send his freedman ZOSIMUS, who had been troubled with spitting of blood, and who, on a former occurrence of this trouble, had received benefit from a voyage to Egypt and a stay there.

(83) *N.H.* 24, 28.

(84) For example, *Larix decidua* Mill. ranges in Italy from 1000 to 2000 metres (rarely from 450 to 2600), according to A. FIORI, *Nuova Flora analitica d'Italia*, 1 (1923), 51. For another reason for recommending larch woods see nn. 130-135 *infra*.

(85) PLIN. *Ep.* 8, 1, 2 describes a case of spitting of blood brought on by inflammation of the throat caused by dust.

(86) *De Rat. Vict. in Morb. acut.*, p. 63, KÜHN.

(87) *Ep.* 5, 14, 1.

(88) *phthisiscentibus.*

(89) *Vit. Hadr.* 25, 6.

(90) *Ep.* 5, 19, 7.

More interesting than Baiae are the upland resorts not far from it. CASSIODORUS (91), in the sixth century after Christ, describes in some detail the Mons Lactarius, which is today known as Monte Lattaro, S.E. of Castellammare di Stabia on the Bay of Naples. A patient whom he knew, suffering from severe coughing and weakness, from the divine qualities of that mountain had received great relief. The wholesomeness of the air and of the milk produced by cows feeding upon the lush grass is such, he says, that " those whom the advice of the doctors cannot aid simply the drinking of milk seems to help, restoring to its original condition the power of nature that has been relaxed by sufferings." This milk, he continues, is so rich that it sticks to the fingers when poured into vessels, and has unusual fattening qualities. This place resembles another resort which GALEN (92) calls Tabiae, and describes with great enthusiasm. A young patient of his, troubled with ulcers in the trachea and with cough and pains, went by ship down the Tiber and to the Bay of Naples, and at Tabiae took the milk cure with wonderful effect. The place lies high, with dry air and good feed for cattle; it is about three or four miles from the sea, exposed to the SE., E., and N. winds; with no lakes, swamps, or rivers near by, and with heat from Vesuvius (upon the lower slopes of which it may have been located) helping to dry the air. Finally PROCOPIUS (93), in the sixth century, declares that the air of Mt. Vesuvius is light and healthful, so that since the remote past consumptives have been sent there by their physicians. In Greece Arcadia had some of the same qualifications as the seat of a milk cure (94), while the shrine of Amphiaraus at Oropus (on the boundary of Attica and Boeotia) is thought by Dr. W. H. D. ROUSE (95) to indicate that this god specialized in lung troubles, because of the great number of votive breasts found at his shrine, all presented by men, one of whom gave sixty or seventy.

(91) *Variae*, 11, 10, 1 ff. The work of F. DI CAPUA, *Dall' antica Stabia alla moderna Castellammare* (1936), I have not seen, but learn from the review by A. TACCONE (*Il Mondo class.* 8 (1938), 232-233) that it discusses the milk cure in the hills back of Stabiae.

(92) X, 362-366.

(93) *Hist. Bell.* 6, 4, 30.

(94) PLIN. *N.H.* 25, 94; 28, 125.

(95) *Greek Votive Offerings* (1902), 212.

Next after favored localities we find mention of rest (96) (though SENECA (97) says the doctor will tell you not to overdo rest, a mistake to which lassitude is prone), warming drugs (98), woolen wrappings (99) or grease applied to the chest and shoulders (100), and moderate exercise, such as reading aloud (101), breathing exercises, gentle rocking of the body (102), or especially a sea-voyage, usually to Egypt (103). HIPPOCRATES (104) is most insistent that the patient begin his walking very moderately, and even when recovered refrain from running in the wind, horseback-riding, shouting, and paroxysms of anger, lest the disease recur. (Perhaps similarly GALEN (105) advises against upward purges). PLATO (106) describes a trainer named HERODICUS who became a valetudinarian, blended gymnastics and medicine, and thus postponed his death, though his malady was incurable. If he departed in the least from his fixed regimen he suffered tortures, but keeping steadily to it he lived to a doting old age. PLUTARCH (107), in speaking of this same man, expressly tells us that his disease was phthisis. Diet in general is mentioned by SENECA (108), and more particularly HIPPOCRATES (109) urges care in the use of wine (110). Liquid foods (111) and gruel (112)

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(96) CELS. 2, 4, 1; cf. ANTHIMUS, 76-77.

(97) *Ep.* 78, 5.

(98) E.g., DIOSCUR. 3, 1, 3; in 2, 76, 17 he says that all the animal fats are warming.

(99) ARTEMID. 4, 54. HIPPOCR. *De Rat. Vict. in Morb. acut.* 22 warns against continued heat, which dries the lungs and causes empyema.

(100) PLIN. *N.H.* 28, 138.

(101) SEN. *Ep.* 78, 5.

(102) CELS. 2, 15, 4.

(103) SEN. *Ep.* 78, 5; PLIN. *N.H.* 24, 28; 28, 54; 31, 62; PLINY THE YOUNGER, *Ep.* 5, 19, 6; CELS. 3, 22, 8 (advising that a denser air be sought than that which the patient leaves); 4, 10, 4 (travel and voyages are good for all coughs).

(104) *De intern. Affect.* pp. 429-430 KÜHN.

(105) XV, 335; XVII B, 666.

(106) *Rep.* 3, 406*a-b*.

(107) *De sera Num. Vind.* 9.

(108) *Ep.* 78, 5.

(109) *De intern. Affect.* p. 429 KÜHN.

(110) Cf. SEN. *Ep.* 78, 5. PS.-ARIST. *Problems*, 28, 1 observes, however, that intemperate men must not too suddenly abandon all use of wine, to which their bodies have become wonted.

(111) SEN. *l.c.*; DIOSCUR. *Simpl.* 2, 40.

(112) HIPPOCR. *De intern. Affect.* p. 429 KÜHN; ARTEMID. 1, 31.

are recommended, and AELIAN (113) relates that one CHRYSERMUS, in the reign of NERO, was cured of spitting of blood and wasting away, by drinking, at the command of the god Serapis, the blood of a bull. But most highly valued, as I have already intimated, was milk, either that of cows, goats, or sheep (114), especially fresh from milking and drunk warm (115), or that of pigs (116), or, even better, human milk (117). Some believe, says GALEN, that ulcer of the lungs can be cured by milk *alone* if this is employed before the lung becomes calloused. Woman's milk, as the kind most natural to human beings, is preferred by many, especially if sucked directly from the breast, as by infants (118). Butter is also praised, when boiled with honey—a combination called by TERTULLIAN (119) a food natural to infancy, as children were fed milk and honey (120)—, and honey itself often appears as a vehicle for various other recommended remedies (121).

Medicines employed for this disease were numerous, and range from certain repulsive—not to say superstitious—types cited by PLINY (122), in which the smoke of various kinds of burning dung plays a large part, to the numerous simples listed by PLINY in his *Natural History* (123), by COLUMELLA (124), DIOSCU-

(113) *N. A.* 11, 35. SEREN. SAMMON. *Lib. medic.* 342 recommends *intritas vino cochleas hausisse.*

(114) HIPPOCR. *Aphor.* 5, 64; *De intern. Affect.* p. 431 KÜHN; PLIN. *N.H.* 24, 28; 28, 125 (milk is especially wholesome in the spring, when derived from fresh herbage; cf. 25, 94); CELS. 3, 22, 10; DIOSCUR. *Simpl.* 2, 40; GALEN, XVII B, 875; CASSIOD. *Variae*, 11, 10, 1.

(115) ANTHIMUS, 76.

(116) PLIN. *N.H.* 28, 130.

(117) DIOSCUR. 2, 70, 6; *Simpl.* 2, 40; GALEN, VI, 775.

(118) GALEN, VI, 775, VII, 701; X, 336; 474.

(119) TERTULL. *Adv. Iud.* 9. Cf. DIOSCUR. *Simpl.* 2, 40; ANTHIMUS, 77. On butter and honey as a combination cf. ORIG. *c. Cels.* 4, 1, 8.

(120) E.g., TERTULL. *Adv. Marc.* 1, 14; cf. 4, 21.

(121) PLIN. *N.H.* 22, 158; MUSA, *De Herba Vett.* 9; 19; DIOSCUR. 3, 1, 3; 4, 14; etc.

(122) *N.H.* 28, 230-231. Under superstition may be classed the practice described in HIPPOL. *Philosophum.* 9, 11 [cited by L. THORNDIKE, *Magic and exp. Science*, 1 (1929), 373] of the sect called Elchasaites who dipped in cold water forty times a week persons afflicted with consumption or demonic possession.

(123) E.g., 22, 76; 22, 82; 22, 158; 23, 154; 24, 140; 24, 145; 24, 154; 25, 86 (the newly-found remedy of the herb *consiligo* from central Italy helps cases which have been given up by others); 26, 109-110; also many cough remedies.

(124) 6, 14.

RIDES (125), Ps.-APULEIUS (126), MUSA (127), and MARCELLUS EMPIRICUS (128), as well as by the standard medical writers. Of squills, in particular, GALEN (129) speaks in the highest terms : " We have often seen consumptives given up by all their doctors restored to their original health by vinegar of squills *(skilletikon oxos)*." Another favorite remedy is various types of pitch or resin. The Roman architect VITRUVIUS (130) speaks of a liquid, honey-colored, resin from the larch, which is beneficial for this disease; PLINY (131) says liquid pitch is drunk as a medicine; and DIOSCURIDES (132) describes a resin to be dissolved in the mouth. Further, GALEN (133) considers pitch a remedy for leanness, and elsewhere (134) states that pitch and resin cause suppuration (135). In addition to these simples many remedies were compounded of several ingredients, which often bore the names of the physicians who had devised them, as we may see from passages in GALEN (136) and MARCELLUS EMPIRICUS (137). The licking of limestone from Assos in the Troad, mentioned by PLINY (138) as a remedy for phthisis, seems to be in a class by itself.

The frequency of tuberculosis in antiquity I know no method of estimating. Some years ago one of my students made a preliminary examination of several thousand Roman funerary inscriptions bearing the ages of the deceased, and, while I have no figures now available for citation, we were both struck by the rather high rate of mortality during the years at which the disease is most prevalent. (Naturally the inscriptions themselves

(125) E.g., 3, 1, 3; 3, 17, 2; 4, 1, 4; etc.

(126) *Herb.* 1, 5; 55, 2; 126, 1.

(127) *De Herba Vett.* 9; 19.

(128) 14, 50; chap. 16 *passim.*

(129) XIV, 569; cf. COLUM. 12, 83. It also appears as an ingredient in other remedies, e.g., in a troche described by GALEN, XIII, 32.

(130) 2, 9, 17. Cf. n. 84 *supra.*

(131) *N.H.* 24, 39; 28, 138 (taken in egg).

(132) 1, 72; *Simpl.* 2, 40.

(133) VI, 416.

(134) XI, 734.

(135) *ekpyiskei.*

(136) See ASSMANN's index in KÜHN's edition, XX, 586 (s.v. *Tabis cura*).

(137) E.g., 14, 70, for a lozenge invented by Dr. EUTYCHIANUS; cf. GALEN, XIII 32 for a troche.

(138) *N.H.* 36, 133.

very rarely mention the cause of death, and I have noted none in which phthisis is named).

In conclusion I may mention certain known or alleged victims of this disease. ANTISTHENES, founder of the Cynic school of philosophy, is said (139) to have died of a lingering and painful disease, which one source (140) more specifically calls phthisis, yet since others (141) describe it as having prevented micturition and since we know that ANTISTHENES lived to the age of eighty or more (142) one might guess that his trouble was not unconnected with an enlargement of the prostate gland. King ANTIGONUS DOSON of Macedonia, however, pretty certainly died of phthisis in 221/220 B.C. (143). The distinguished Achaean general and statesman ARATUS (144), was poisoned, whereupon he suffered from fevers, a dull cough, spitting of blood, and death—the Greek term is *phthoran*, which the late Professor PERRIN translates, possibly too freely, as 'consumption.' The Roman philosopher SENECA, when in the early forties, was let off from death by the Emperor CALIGULA because a female attendant insisted that he was in an advanced stage of consumption and would soon die in any event (145). Whether his was a genuine case, arrested or cured, or whether this was merely a lie to save his life it is hard to decide, yet SENECA lived to be at least sixty-six (and perhaps even seventy-three) years old, and died, not by disease, but by suicide at the order of NERO. The iniquitous TIGELLINUS, who ministered to NERO's worst vices, was similarly spared by the Emperor GALBA (146) on the ground that he was far advanced in consumption, but he was shortly thereafter executed by GALBA's successor OTHO. The Emperor HADRIAN, who had for some time been subject to nosebleed (147), is said by DIO CASSIUS (148) to have become consumptive from loss of blood, and from this to

(139) JULIAN, *Or.* 6, p. 181*a*.
(140) *Anth. Pal.* 7, 115, 3, ap. DIOG. LAERT. 6, 18.
(141) LUCIAN, *Parasit.* 57, and schol.; cf. SUID. s.v. *Antisthenes*.
(142) NATORP in PAULY-WISSOWA, *Realencycl. d. cl. Altertumswiss.* 1 (1894), 2539.
(143) PLUT. *Cleom.* 16, 5; 30, 1-2.
(144) PLUT. *Arat.* 52, 2—53, 1. His death falls in 213 B.C.
(145) DIO CASS. 59, 19, 8.
(146) PLUT. *Galba* 17, 4.
(147) DIO CASS. 69, 17, 1.
(148) 69, 20, 1.

have passed into dropsy. After prolonged suffering, which neither medical aid nor magical charms relieved, in 138 A.D. "he abandoned his careful regimen, and by indulging in unsuitable foods and drinks met his death, shouting aloud the popular saying: 'Many physicians have slain a king'" (149). Even before HADRIAN'S death, L. COMMODUS, whom he had adopted as his heir (despite the fact that COMMODUS often vomited blood) (150), met his death by a sudden and severe haemorrhage (151).

I am quite aware that in this brief sketch the precise chronological development of the diagnosis and cure of this disease has been inadequately treated. A full handling of the subject might well show the exact state of knowledge at the times, let us say, of HIPPOCRATES and of GALEN and at intermediate and subsequent dates, but this would involve more repetition and more detail than is here possible, and, like a more extensive discussion of the cases described by HIPPOCRATES and GALEN, might more appropriately be the work of a professional physician (152). Perhaps, however, an idea of the distance to which ancient empiricism was able to go, even without any germ-theory of disease to assist it, may be not entirely without interest.

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(149) DIO CASS. 69, 22, 4; cf. SPART, *Hadr.* 24, 1; 24, 8; 25, 6.

(150) DIO CASS. 69, 17, 1.

(151) DIO CASS. 69, 20, 1.

(152) There may here be mentioned the works of L. F. FLICK, *Development of Our Knowledge of Tuberculosis* (1925), in which pp. 9-73 deal with the Greeks and Romans; H. MORITZ, *Die Behandlung d. Lungentuberkulose im Altertum.* Med. Diss., Münster (1934)—the latter known to me only from a bibliographical note.

The lunar mansions in Egypt

It is well known to students of oriental astronomy that a system of grouping the equinoctial-ecliptic stars into 28 sets was widely used in Asia and can be traced in India and China well back into the first millennium B.C. (Jyotisha Vedanga, Atharva Veda, Taittiriya Brahmana, Hsia Hsiao Cheng, Chou Li, Huai Nan Tzu). A similar system is found in Arabia, being mentioned twice in the Kuran (7th century A.D.) and occurring in the old Arabian poems some of which are pre-Koranic. These three systems, although differing in detail, have so many points in common that they must have had a common origin. Incidentally the dates attached to the first two indicate some sort of communication between India and China prior to the Han dynasty.

In the Bundahishn (3rd century A.D.?) there is a Persian list of similar divisions and in ALBIRUNI's " Chronology of the Ancient Nations " (13th century) there are Sogdian and Khwarasmian lists.

FRITZ HOMMEL (*Deutsche Morgenländ. Ges. Zeitschr.*, Vol. 45, 1891, pp. 592-619) has made gallant efforts to connect the Arabic names with those of certain Babylonian star lists. He has in particular endeavoured to associate the mansions with the 24 extra-ecliptic stars referred to by DIODORUS SICULUS, but his reasoning seems forced and unconvincing. DE SAUSSURE, BIOT, WEBER, WHITNEY, SEDILLOT and many others have discussed the origin, diffusion and national priority of the mansions in great detail but no final conclusion has been reached.

There is certainly no evidence that the Babylonians ever had a system of dividing the planetary zone into 28 parts. Their classification seems to have been definitely one of 12 or 36 parts, possibly not greatly differing from the 36 Egyptian dekans, save that in each group of three, the individuals were successively above, on and below the equator (The three belts of Enlil, Anu and Ea).

The Egyptian dekanal system of 36 stars (or star groups) goes back at least to the tenth dynasty (say 2000 B.C.) and possibly to the Pyramid era and persisted without important change until the Roman period. It still survives in the zodiacal "faces" of the classical astrologers.

There is no record in the monuments of a system of 28 divisions in Egypt, unless the tabulation of the dekans in 28 columns (excluding Sothis) in the SENMUT ceiling and the Karnak clepsydra (say 1500 B.C.) is so regarded. As the ceilings of SETI I, RAMESES II and RAMESES III show a smaller number of columns, probably this has no significance and is merely a matter of artistic lay-out.

That other systems of star classification existed in Egypt is shown by the star tables in the tombs of RAMESES VI and RAMESES IX, but as far as can be seen these tables are either based on a numeration of 30 or 36 stars or on no numerical grouping at all.

Nevertheless we find in ATHANASIUS KIRCHER's works (*Oedipus Aegyptiacus*, 1652, and *Lingua Aegyptiaca Restituta*, 1644) a list of the twenty-eight mansions and their Coptic names. He was well aware that Arabian and Indian lists also existed but asserts the Egyptian origin of the scheme : "Est autem Aegyptiorum figmentum, qui Lunae cursum 28 dierum numero definientes, eidem singulo die naturali unam stationem, una cum Genio eius stationis veluti administro, quodem et conservatore assignabant" (*Oedipus Aegyptiacus*, Vol. 2, Pt. II, p. 241-7).

It is of course well known that KIRCHER was a most imaginative man and that little reliance can be placed on many of his statements. POGO has pointed out however his acute identification of fragments of clepsydrae and it is a fact that he gives a full list of the Coptic names of the mansions which can scarcely be fictitious. Unfortunately his sources are only indicated by a list of authors consulted and the probable conclusion to be drawn is that he borrowed the names from an Arabic writer. It is to be presumed that the latter asserted (or, at least, did not deny) the Coptic priority.

The Coptic names agree in several instances with the Arabic ones, so that one of the two is perhaps a translation, but which of the two remains to be considered. KIRCHER also gives (*Lingua Aegyptiaca Restituta*, p. 52) the Coptic names of the signs of the Zodiac. These are in corrupt Greek, resembling those in the Bundahishn, except two variants which appear to be Egyptian.

They are " Thoume " for Virgo, and " Phrititthi " for Aquarius. The first is obviously the Egyptian dekanal name " Temut," of which HEPHAISTION's Greek form was " Tôm," agreeing with the constellation Virgo. The second resembles the name of one of the mansions near to Libra, but cannot be the same.

In the attached table the names of the mansions as stated by KIRCHER are given, together with their Arabic equivalents (some of which he also gives), the meanings of the latter and the probable interpretations of some of the Coptic names.

LIST OF LUNAR MANSIONS
COPTIC (" NIMONE ") & ARABIC (" MANAZIL ")

COPTIC	ARABIC	MEANING OF ARABIC	NOTES RE COPTIC NAMES
PI-KUTÔRION	SHARATAN	The Two Signs	" Pi," Egypt^{n} article
KOLIÔN	BUTAIN	Little Paunch	Gr. koilia, belly.
ÔRIAS	THURAIYA	Pleiades	
PI-ÔRION	DABARAN	Hyades	
KLUSOS	HAK'A		
KLARIA	HAN'A		
PI-MAHI	DHIRA'	Lion's Paw	Ed. PI-MEH the cubir
TERMELIA	NATHRA	Nostrils	
PI-AUTOS	TARF	Eye	
TITEHNI	DJABBHA	Forehead	Eg. TA-TEHEN, the forehead
PI-KHÔRION	ZUBRA	Mane	Gr. Khorion, skin ?
ASPHULIA	SURFA	Weathercock	Gr. Asphaleia, security ?
ABUKIA	SAWWA'	Barkers	
KHÔRITOS	SIMAK	Prominent	
KHAMBALIA	GHAFR	Cover	Gr. Kamara, cover.
PRITITHI	ZUBANA	Princers	
STEPHANI	IKLIL	Crown	Gr. Stephane, crown. } Scorpio
KHARTHIAN	KALB	Heart	Gr. Kardia, heart. } Scorpio
AGGIA	SHAWLA	Tail	Gr. Alkaia, tail. } Scorpio
NIMAMREH	NA'A'IM	Ostriches	
POLIS	BULDA	Town	Gr. Polis, town.
UPEU TÔS	SA'D AL DHABIH	Luck of slayer	Note, " Upeu " corresponds to " Sa'd "
UPEU RITOS	SA'D BULA'	Luck of devourer	Note, " Upeu " corresponds to " Sa'd "
UPEU INEUTES	SA'D AL SU'UD	Luck of lucks.	Note, " Upeu " corresponds to " Sa'd "
UPEU THERIAN	SA'D AL AKHBIYA	Luck of tents.	Note, " Upeu " corresponds to " Sa'd "
ARTULOS	FARGH AL AWWAL	Fore socket	Gr. Arthron, socket
ARTULOSIA	FARGH AL THANI	Back socket	Gr. Arthron, socket
KUTÔN	BATN AL HUT	Fish Belly	Gr. Kutos, Body, belly

The simplest hypothesis is that the Coptic names are just translations from the Arabic, but it is minutely possible that they are based on an Egyptian tradition. Alternatively the Copts may have obtained them from the Persians at an earlier date than that of MUHAMMAD. SHAHPUR I in the 3rd century caused Hindu and Greek notions to be incorporated in the Zoroastrian literature (WEST in *S. B. E.*, Vol. 4, p. XLVI) and it is probable that it was at this date that the mansions were borrowed from India and so appear in the Bundahishn, together with the Greek signs of the zodiac. The Persians controlled Egypt for a short period in the 7th century A.D. just prior to the Mohammedan conquest, and the mansions may have entered Egypt then, but this seems rather late.

Presumably, but not certainly, KIRCHER's authority for the Egyptian origin of the mansions comes from an Arabic source. Is there any trace in surviving Arabic writings of this opinion?

Unfortunately the Persian names of the mansions are untranslatable, with perhaps the exception of "Gau," the Bull, which appears to be identical with the Chinese "Niu," also the Bull.

There is no clear connection between the Coptic names and the Egyptian dekans, unless perhaps "Kharthian," the Heart, can be identified with HER-AB-UA, The Heart of the Ship, Dekan No. 15 in the older lists. The Chinese mansion is also called "Heart."

"Kuton" may be equivalent to KHAT-NUT, the Belly of Heaven, a very important star group near the dekan KHENT-KHERT (No. 27) located near to the constellation Aries. This is the first in KIRCHER's list but last in the usual Arabic lists. The Arabic name of this mansion is "The Belly of the Fish," which also suggests some association with the Egyptian constellation.

As a matter of speculation it may be suggested as quite possible that the Egyptians observed the course of the moon amongst the dekanal stars and so arrived at a twenty seven or twenty eight day grouping, but as yet there is no evidence of this.

London. HERBERT CHATLEY.

Remarks on the study of Babylonian mathematics

The mathematics which was developed in the Mesopotamian region first by Sumerians then by Akkadians and by other people and which we call for the sake of convenience " Babylonian mathematics " (as if it were the creation of a single nation) has been studied with great intensity within recent years, witness two monumental works by the Austrian exile OTTO NEUGEBAUER (*Mathematische Keilschrift-Texte*, 3 vols., Berlin, 1935-7; *Isis* 26, 63-81; 28, 490-91) and by the Frenchman FRANÇOIS THUREAU-DANGIN (*Textes mathématiques babyloniens*, Leiden 1938; *Isis* 31, 405-25). These two scholars agree in giving credit to the old " Babylonians " for a deeper mathematical knowledge than had been hitherto suspected, but they disagree as to details.

This is very hard on historians of science and particularly on historians of mathematics, who realize the fundamental importance of Babylonian (as well as of Egyptian) mathematics and would like to give their students as good an account as possible of pre-Hellenic mathematics yet cannot undertake the formidable task of interpreting themselves the original documents. When the experts disagree the non-experts are in an awful quandary.

The situation is this. The two protagonists in that field to-day are THUREAU-DANGIN and NEUGEBAUER. The former was born in Paris in 1872, being the son of the great Catholic publicist PAUL THUREAU-DANGIN (1837-1913). He began Assyriological studies in 1892 and his *Recherches sur l'origine de l'écriture cunéiforme* appeared as early as 1898-9, that is, more than forty years ago, and since then he has devoted all of this time and energy to a great many investigations covering the whole domain of Babylonian philology and archaeology. In 1917 he was elected a full member of the Académie des inscriptions. The *Revue d'assyriologie et d'archéologie orientale*, one of the leading

archaeological journals in the world, established by JULES OPPERT (1825-1905) and EUGÈNE LEDRAIN (1844-) in 1884, was taken over in 1910 by the abbé JEAN VINCENT SCHEIL (1858-) and THUREAU-DANGIN (1) and has been led by them ever since. The *Revue* covers naturally the whole field but in recent years, from 1921 on, it has contained an increasing number of mathematical papers which have been listed, and sometimes analyzed, in *Isis*. For an estimate of THUREAU-DANGIN as an Assyriologist see, for example, Sir E. A. WALLIS BUDGE : *The rise and progress of Assyriology* (p. 218, London, 1925; *Isis* 9, 547), for his portrait and father SCHEIL's portrait see *ibidem*, p. 214.

OTTO NEUGEBAUER began his investigations much later, not only because he is considerably younger than this French rival (he was born at Innsbruck in the Austrian Tirol in 1899, and by that time THUREAU-DANGIN was already a full-fledged Assyriologist), but also because he was primarily trained as a mathematician. It is true he revealed historical interests very early, for he studied Egyptology (under HERMANN KEES and KURT SETHE) in Göttingen 1922-3 as well as mathematics, and obtained his doctor's degree in that city in 1926 for a thesis on Egyptian fractions (Berlin, 1926; *Isis* 9, 546). In the following year he published a memoir on the origin of the sexagesimal system (2) (Berlin, 1927; *Isis* 11, 525). In 1929, he was, with J. STENZEL (Kiel) and O. TOEPLITZ (Bonn), one of the co-founders and co-editors of the splendid collections *Quellen und Studien zur Geschichte der Mathematik* (3). The *Studien* contain many memoirs of his on Egyptian and Babylonian mathematics, and his magnum opus, *Mathematische Keilschrift-Texte*, constituted the third volume of the *Quellen*. In 1934, he published the first volume of his history of ancient mathematics (*Isis* 24, 151-3). He has completed a survey of Babylonian astronomy, which, I understand, is almost ready for the printers.

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(1) The latter's mathematical studies go back at least to 1897, for in his article " Les chiffres fractionnaires dans l'écriture babylonienne archaïque " (*Beiträge zur Assyriologie*, vol. 8, 588-9, 1898) he referred to a shorter note on the same topic which had appeared in the *Revue sémitique* (vol. 5, 171-73, 1897).

(2) A subject treated also by THUREAU-DANGIN : *Esquisse d'une histoire du système sexagésimal* (Paris, 1932). Revised edition *Osiris* VII, 95-141, 1939.

(3) He resigned that editorship in 1938.

In order to measure NEUGEBAUER's astounding capacity for work and his equally remarkable ability to organize the work of other people, it is necessary to realize that his historical investigations were combined all the time with other activities. He contributed very largely to the organization of the Mathematical Institute of Göttingen, which was in pre-Nazi days the Mecca of mathematicians from all over the world. He was the chief editor of the *Zentralblatt für Mathematik* from the time of its foundation (1931) to 1938, when increasing restrictions of intellectual freedom obliged him to resign (*Isis* 31, 518). He was one of the two editors of the *Zentralblatt für Mechanik* from 1933 on, and he edited the series of twenty-five monographs entitled *Ergebnisse der Mathematik und ihrer Grenzgebiete* (1932-38). He is now connected with the University of Copenhagen but from 1939-40 on will be professor of mathematics in Brown University, Providence, Rhode Island.

To return to our main subject, the elder man THUREAU-DANGIN, is primarily an Assyriologist and an archaeologist, while the younger one is primarily a mathematician with a deep interest in ancient science. Looking at it superficially one would expect the former to have a tremendous philological advantage over the latter but to be handicapped on the mathematical side. However, while the philological equipment can never be too good, and is at its best barely sufficient in the present stage of Assyriology, the mathematical equipment need not be so elaborate. A vast amount of NEUGEBAUER's mathematical knowledge is simply useless for his archaeological purpose. In order to understand Babylonian mathematics it suffices to know well elementary geometry and elementary algebra, that is, high school mathematics, and such is generally well taught in the French lycées and colleges, even in the classical sections.

The disagreements between the two experts when they occur are truly fundamental, in the sense that they concern the text itself, being due to different " readings " of it. Please observe that I do not say translation, for the disagreement goes deeper than that. It is not simply a matter of translating a word as might be the case for a Greek or Arabic text, but of determining whether the cuneiform symbols are to be read in one language or in another. NEUGEBAUER reads them in the old Sumerian

style, but the scribes of the clay tablets which have come to us were Babylonians who used or misused the ancient symbols for the writing of their own (Semitic) language. THUREAU-DANGIN concludes that we should read these tablets in the spirit in which they were written. For a discussion of that topic see GANDZ' article on Conflicting interpretations (*Isis* 31, 405-25). It will suffice here and now to remark that if two interpretations of the same text diverge materially, one of these interpretations must be wrong; it does not follow of course that the other is right. The interpretation, that is, the purely philological work, is absolutely fundamental. If a text is correctly read and translated, further elucidation of it by the modern mathematician may be right or wrong; if the text is not correctly read *everything* is wrong.

Taking that into account one would expect the veteran Assyriologist to be more often right than his young competitor. However, to give his interpretations the preference *a priori* would be foolish; it would be even more foolish to accept uncritically the interpretations of his rival. The fact is that the correctness or uncorrectness of an interpretation can only be determined by a philologist on philological grounds, by a scholar arguing from the point of view of the scribe rather than from the point of view of a modern mathematician. The scribe, we may assume, had some knowledge of the past (of his past); we are certain that he had no knowledge of the future. As long as the experts disagree, the honest historian of mathematics who is not an Assyriologist (that is every historian except a very few) can do nothing but wait and restrict himself in the meanwhile to the topics about which agreement already obtains.

It is desirable that that state of suspense be shortened as much as possible and a journal like *Isis* can be of great help in such an emergency. I have already published many papers on Babylonian mathematics and astronomy in *Isis* and *Osiris* (see list in appendix) and I am ready to publish many more, for the differences of opinion between THUREAU-DANGIN and NEUGEBAUER constitute a challenge to scholarship which must be met. If this appeal is successful and I am able to publish new Babylonian materials in the following volumes or new interpretations of them, I trust readers who are not interested in those questions will

realize their importance and be patient. That is now one of the advancing edges of our field and its needs must be served.

As opposed to the odious disputes between nations or races fanned into hatred by criminals or fanatics, this is a friendly rivalry, the very spice of scholarly life. MM. THUREAU-DANGIN, NEUGEBAUER and others, however much they may disagree on sundry points, have supreme interests in common, to wit, the love of truth, the desire to find it in its purest state and to explain it as clearly as possible. The ultimate truth unites them already, even if they be temporarily separated by their partial glimpses of it. Truth is more essential to them than anything else, not excluding personal pride. I understand that very well because it has always been my policy to insert in *Isis* whatever corrections were submitted to me as promptly as possible. I accept those corrections with alacrity and am always ready to publish them *urbi et orbi*, not because it is my duty but rather because it is one of my main pleasures. A prolific scholar is bound to make mistakes from time to time and there is no shame in that provided he be willing to acknowledge his errors and change his ways.

Isis and *Osiris* are wide open to competent scholars offering new materials or new ideas on Babylonian mathematics or astronomy. Considering that both journals, in spite of their great capacity, are already overtaxed and must give room to many other branches of the history of science I must ask authors to be as terse as possible. Considering the smallness of our resources, I must ask them also not to insert cuneiform signs (or hieroglyphics) into the text but to concentrate them in small groups which may be reproduced photographically even as other illustrations.

One more suggestion. Experts could render non-experts a great service by the preparation of a primer of Babylonian mathematics wherein a few examples would be completely explained from the very beginning, each sign being accounted for as well as each combination of signs. This would help the non-expert to go back to the sources in a subordinate manner. He would not be able to decipher new documents, nor would that be his ambition, but he would be able to some extent to form an opinion on the original investigations. Such a primer of Babylonian mathematics would render the same service to historians as the late chancellor CHACE's edition of the Rhind papyrus rendered them for Egyptian

mathematics (Oberlin, Ohio, 1929; *Isis* 14, 251-5). It should be accompanied of course by a glossary of mathematical cuneiforms.

Cambridge, Massachusetts. GEORGE SARTON.
December 26, 1938.

APPENDIX

Memoirs on Babylonian mathematics and astronomy published or reviewed in Isis and Osiris

Archibald, Raymond Clare. Bibliography of Egyptian and Babylonian mathematics. Appended to ARNOLD BUFFUM CHACE : *The Rhind mathematical papyrus* (in both vols., Oberlin, Ohio, 1927-9). Reviewed by G. SARTON (*Isis* 14, 251-5, 1930).

—— Babylonian mathematics (*Isis* 26, 63-81, 1936).

—— See NEUGEBAUER.

Bortolotti, Ettore. L'algebra nella storia e nella preistoria della scienza (*Osiris* 1, 184-230, 1936).

Gandz, Solomon. The origin of angle-geometry (*Isis* 12, 452-81, 1929).

—— The Babylonian tables of reciprocals (*Isis* 25, 426-32, 1936).

—— Mene mene tekel upharsin, a chapter in Babylonian mathematics (*Isis* 26, 82-94, 1936).

—— The origin and development of the quadratic equations in Babylonian, Greek and early Arabic algebra (*Osiris* 3, 405-557, 1937). A summary of that paper appeared in *Scientia* (249-57, 1937).

—— L'origine e lo sviluppo delle equazioni di secondo grado nell'algebra babilonese, greca e araba (*Atti del* 1° *congresso dell'Unione matematica italiana* (1937), 528-31, 1938).

—— Indeterminate analysis in Babylonian mathematics (*Osiris* VIII, 1940).

—— Conflicting interpretations of Babylonian mathematics (*Isis* 31, 405-25, 1940).

—— See KUGLER ; THUREAU-DANGIN.

Kugler, Franz Xaver (1862-1929). *Sternkunde und Sterndienst in Babel* (2 vols., plus 3 supplt., Münster i.W., 1907-35). Reviewed by S. GANDZ (*Isis* 25, 473-6, 1936).

Meissner, Bruno. *Babylonien and Assyrien* (2 vols., Heidelberg, 1920-4). Reviewed by JULIUS RUSKA (*Isis* 8, 195-8, 1926).

Neugebauer, Otto. *Vorlesungen über Geschichte der antiken mathema-*

tischen Wissenschaften. Erster Band. Vorgriechische Mathematik (Berlin, 1934). Reviewed by R. C. ARCHIBALD (*Isis* 24, 151-3, 1935).

—— *Mathematische Keilschrift-Texte* (3 vols., Berlin, 1935-7). Reviewed by R. C. ARCHIBALD (*Isis* 26, 63-81, 1936; 28, 490-1, 1938).

—— Jahreszeiten und Tageslängen in der babylonischen Astronomie (*Osiris* II, 517-50, 1936).

Ruska, Julius. See MEISSNER.

Sarton, George. See ARCHIBALD.

Thureau-Dangin, François. History of the sexagesimal system (*Osiris* 7, 95-141, 1939).

—— *Textes mathématiques babyloniens.* Transcrits et traduits (Leiden, 1938). Reviewed by S. GANDZ (*Isis* 31, 1939).

Vetter, Quido. Quatres notes sur les mathématiques babyloniennes (*Osiris* I, 692-702, 1936).

Vogel, Kurt. Bemerkungen zu den quadratischen Gleichungen der babylonischen Mathematik (*Osiris* I, 703-17, 1936).

An abundant bibliography of the subject could easily be culled from the Critical bibliographies appearing periodically in *Isis* (thus far 57 have been published from 1913 on) in the section entitled " Babylonia and Assyria."

January 4, 1939. G. S

Studies in Babylonian mathematics II

Conflicting interpretations of Babylonian mathematics (*)

ABBREVIATIONS

MKT	*Mathematische Keilschrift-Texte*, by O. NEUGEBAUER, 3 volumes, Berlin, 1935-7.
N.	O. NEUGEBAUER.
QE	"The Origin and Development of the Quadratic Equations in Babylonian, Greek, and Early Arabic Algebra," by S. GANDZ. in *Osiris* III, 1937, pp. 405-557.
RA	*Revue d'Assyriologie et d'Archéologie Orientale*, Paris.
TH. D.	F. THUREAU-DANGIN.
TMB	*Textes Mathématiques Babyloniens*.

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(*) A propos of the publication of F. THUREAU-DANGIN, *Textes Mathématiques Babyloniens*, XL + 243 pages, in-4. Leyden, E. J. BRILL, 1938 (25 guilders).

I. — Introduction

§ 1. — *Mathematics and Philology*

In the cradle of its infancy mathematics was literature, ancient literature. To interpret ancient literature the philologist alone is competent. History of ancient mathematics is, to a certain degree, history of literature, philology, mathematical philology, if I may coin this new term.

The mathematician and the philologist approach reality from two different angles. The mathematician seeks the eternal, absolute truth. Like the theologian of the Middle Ages he is a dogmatist. Like the modern scientist in general, he is little interested in the history of his discipline and still less so in its philology. It was well said (1) : " The scientist is so completely bent on the future that he is unable to look backward. He is moving forward so fast that he has no time or patience with tradition." To investigate the past seems to him a waste of time and energy. What has been is after all only a thing of the dead past, to be forgotten and discarded. Not so the philologist. His main business is to study this dead past and to revive it. To dig out the relics and traditions of remote times and vanished civilizations and to interpret their significance, to see to it that they shall not be forgotten and discarded. His main task is to build up the memory of the human race, to explore the growth and evolution of civilization.

However, for some reason or other, the philologist has, so far, shown only very little interest in mathematics. Hence history of mathematics, of ancient mathematics in particular, has long remained a fallow field, unsown and untilled. Especially the critical investigation of mathematical texts has long been sadly neglected.

(1) Sarton, in *Isis*, XXIX (1938), p. 11.

II. — Babylonian Mathematics

§ 2. — *The Discovery of Babylonian Mathematics*

This is best illustrated by the history of Assyriology and Babylonian mathematics. Almost a century passed since, around 1850, the pioneers of Assyriology, Rawlinson, Hincks and Oppert first succeeded in deciphering the cuneiform script. Since then a host of European scholars continued to make ceaseless efforts in the unearthing of the priceless treasures of the Babylonian past, thus broadening our horizon and enriching our knowledge about ancient history and literature. The systematic edition and investigation of the mathematical texts, however, is an undertaking of the last decade.

In the decipherment, translation and interpretation of the mathematical texts of the Babylonians, many scholars have collaborated. Foremost among them are Otto Neugebauer, of Copenhagen, who published the *Mathematische Keilschrift-Texte* in 3 volumes, in 1935-37, and François Thureau-Dangin, of Paris, whose contributions appeared in the RA of the last ten years, and who has just now, in 1938, brought out, in the Publishing House of Brill at Leyden, and under the auspices of the Netherlandish Oriental Society, Het Vooraziatisch-Egyptisch Gezelschap, EX ORIENTE LUX, a concise but comprehensive volume under the title *Textes Mathématiques Babyloniens*. To Th. D. the main credit is due for the sound philological exegesis of these somewhat abstruse texts. N.'s efforts and contributions lie chiefly in the field of the mathematical analysis and interpretation. However, discrimination and great caution are indicated with respect to these mathematical theories and interpretations.

It is the tragic fate of pioneers in every field of human endeavor that their results are only preliminary, that they are soon superseded and replaced by the new improved results of those who come after them. In the reviewer's memoir QE, all the texts dealing with quadratic equations have been submitted to a critical re-examination leading to a new interpretation of the texts and a new conception concerning the development of Babylonian

mathematics. In a recent essay on " Indeterminate Analysis in Babylonian Mathematics " (2), the Babylonian origin of some fundamental Diophantine propositions in the theory of numbers has been demonstrated. On the other hand, from the philological point of view, TH. D.'s new volume constitutes a long step forward toward a better understanding of Babylonian mathematics. Alongside with the MKT, the student will now have to use and compare the interpretation of the TMB for each problem in Babylonian mathematics.

§ 3. — *Transcription of the Text. Sumerian or Babylonian Language*

Apparently the same documents have been read and treated by N. and TH. D., but when we compare the texts as transcribed in the MKT with those of the TMB, we find them to be very different. N. transcribes them in the archaic Sumerian language, while TH. D. renders them in the relatively younger Babylonian language. How is this to be explained, and which course is to be recommended as the correct one?

The cuneiform script was, in all probability, invented by the Sumerians in a very remote time going back to the fourth or perhaps to the fifth millennium B.C. Originally, the Sumerian cuneiforms were, like the Egyptian hieroglyphs, a pictographic system, in which each picture represented an idea, each thing had its special symbol and ideogram. When the Semitic Babylonians came into the country, they adopted this form of writing, but at the same time they adapted it to their own Semitic language, modifying the original ideograms into conventional characters which could also serve as phonetic symbols for the syllables of their own language. Thus the Babylonian scribe had at his disposal a system of writing, by virtue of which one and the same manuscript could be read in two different languages, in the Sumerian as well as in the Babylonian. Which form of transcription should be chosen, was already in Biblical times a mooted question. The likelihood is that the compilers of the Bible, or rather the story-tellers and

(2) Soon to appear in *Osiris*, vol. VIII.

historiographers of old Israel, had already grappled with the same problem. Thus we find in the list of the antediluvian patriarchs some genuine Sumerian names, like ADAM — Sumerian ADIMÉ, and some others in the Babylonian translation, like, for instance, the Sumerian MESKINGASHIR, which is in Babylonian MUTU-ŠA-ELU, hence the Biblical METHUSELAH. N. and TH. D. thus appear to us as the modern representatives of an old controversy of Biblical times, and the writer has long hesitated to try and settle a dispute about which the antediluvian patriarchs had already quarreled.

However, N. himself admits that *there is no doubt about it* that these texts were actually read in the Babylonian language (3). These texts were after all written not by Sumerian but by Babylonian scribes, some of them living as early as about 2000 B.C. and some of them as late as about 200 B.C. Hence TH. D.'s procedure seems to us to be historically more justified. It presupposes a broader and deeper knowledge of Semitic philology and also helps us to a better understanding of the texts. The Sumerian language is still very strange to us. It is neither Aryan nor Semitic but it has some features in common with Turkish and Finnish. The Babylonian language, however, is a Semitic language, closely akin to Hebrew, Arabic and Aramaic, which languages are more familiar to students of Semitic philology. The transcription into Babylonian, therefore, gives at the same time the old mathematical texts in the interpretation of the Babylonian scribes, written in a language more familiar to us. For the sake of illustration, one example of the different transcriptions of one and the same text may suffice :

TMB, no. 171 : Babylonian transcription.

qanûm 1 *ammatum* 1 *ubânu-ta-a-an a-di ig-ga-am-ru im-ta-qú-ta-an-ni šiddam ki-ma-ši al-li-ik* 1 *NINDA* 3 *mišil ammatim šiddam al-li-ik.*

MKT I, p. 240, Rs. 11-14 : Sum. transcr.

gi 1 *kùš* 1 *šu-si ta-àm a-di ig-ga-am-ru ni-ta tuš-ta-an-ni uš ki ma-ši al-li-ik* 1 *GAR* 3 1/2 *kùš uš al-li-ik.*

In the terms *qanûm, ammatum, ubânu, ig-ga-am-ru and al-li-ik,* we at once recognize the Hebrew words קנה, קנה המדה, אמה,

(3) See MKT I, p. VII-VIII in the introduction, and cf. also TMB, introduction, p. XXXIX-XL, where each one is defending his own mode of transcription.

אצבע, גמר, הלך meaning " reed, (measuring reed), cubit, finger, to complete, to walk," but *gi*, *kùš* and *šu-si* sound Turkish to us (4).

§ 4. — *Divergences in the Translation*

Of much more importance are, of course, the discrepancies in the translation which are often of such a degree as to change the whole nature of the mathematical problem or the method of its solution. In the following, I am quoting three problems, giving in parallel columns the different translations of N. and Th. D. The first one is the same that I quoted above for the difference in the transcription.

TMB, no. 171.

" A reed. One cubit (of length). Each time one finger dropped from it till it was reduced to zero. Which distance did I walk? I walked a distance of 1 ninda 3 cubits and a half."

MKT I, p. 241-2, Rs. 11-14.

A distance. You are multiplying it with itself at 1 cubit and 1 finger till the full sum. Up till what length did I walk? I walked 1 *gar* 3 1/2 cubits in length."

The translation of Th. D. makes good sense. One used a reed, the usual measuring rod, of the length of one cubit (= 30 fingers), to measure a certain distance. After each application for measurement, the reed loses one finger till it is reduced to nothing or zero (5). The question is : what distance did he measure? And the answer is : 1 ninda 3 ½ cubits. (1 ninda = 12 cubits; 1 cubit = 30 fingers; hence 15 ½ cubits = 465 fingers). Thus we have here an arithmetical progression, descending from 30 to 1 with $d = 1$: $S = 30 + 29 + 28 + \ldots + 1$.

$$S = \frac{n}{2}(n + 1) = 15\,(30 + 1) = 465.$$

The translation of N. makes no sense at all. In his commentary, on p. 243, the text is interpreted as dealing with a geometrical

(4) Cf. also below, § 6, p. 417, *ad ukullû*.

(5) We see here clearly how some of the data are purely hypothetical and fictitious. The measuring rod that loses one finger with each measurement has nothing to do with reality; it is an academic hypothesis designed to demonstrate the descending arithmetical progression. Cf. also my paper on " Indeterminate Analysis in Babylonian Mathematics," *Osiris*, note 11*a*.

progression of the form : (1 + 1/30 cubit) times (1 + 2 + 4 + 8). In MKT III, p. 65, the interpretation of TH. D. is admitted to be the correct one.

The reverse case of no. 171 is the following problem :

TMB, no. 149.

"I got a reed. 1 finger dropped from it (each time). At the spot where it is reduced to zero : 4 cubits. What was the original length of my reed? The original length of my reed was half a cubit. I unravel the fixed reciprocal of the finger. I multiply it with 4 cubits. I double it. I break [in two] 1, the unit. [I square it.] I add the square to the product of the duplication."

MKT II, p. 42.

He got a reed. 11 fingers he deducted (?)... ... 4 cubits. What is the beginning of my reed? The beginning of my reed is 1/2 cubit. What I have deducted (in) fingers, I multiply with 4 cubits. I multiplied it with two. Exactly 2 fingers, break off (??)... with..."

N. concludes : "The sense of this calculation is totally obscure to me." But, using the translation of TH. D., the meaning becomes clear : One has measured with a rod of unknown length. After each measurement the rod loses one finger till it is reduced to zero. The distance measured is 4 cubits = 120 fingers. How long was the rod? In our symbols the equation would be set up :

$$S = 120; \frac{n}{2}(n + 1) = \frac{n^2}{2} + \frac{n}{2} = 120; \; n^2 + n = 240;$$

$$n = \sqrt{\frac{1}{4} + 240} - \frac{1}{2} = \frac{31}{2} - \frac{1}{2} = 15. \quad 15 \text{ fingers} = \frac{1}{2} \text{ cubit.}$$

The answer was anticipated at the beginning of the procedure. In the latter the reciprocal of the finger is taken as 30, because 1 finger is 1/30 cubit; 4 times 30 = 120; 2 times 120 = 240; $(\frac{1}{2})^2$ is added to 240. The rest is missing, apparently, because there was no more space on the tablet. The missing part must have said in words : $n = \sqrt{\frac{1}{4} + 240} - \frac{1}{2}$. There can be no doubt about it that the calculation was thus concluded. In MKT, III, p. 65, N. recognizes the translation of TH. D. as the correct one.

Finally, I would like to quote a different kind of problem in which the measuring rod also plays a part. Its translation reads :

TMB no. 189.

" I got a reed : its dimension (6) is unknown to me. I broke off from it 1 cubit and then I walked 60 times along the length. I restored to it what I have broken off, and then I walked 30 times along the breadth. The area is 6,15 (7). What is the original (length) of the reed? You in your operations put down 1,0 and 30. For the reed that you do not know put down 1. Multiply with it the 60 times that you walked : 1,0 is the false length. Multiply the same 1 with 30 : 30 is the false breadth. Multiply 1,0, the false length, with 30, the false breadth : 30,0 is the false area. Multiply 6,15, the true area, with 30,0, the false area, you get 3,7,30,0. Multiply the false length with 0;5, which was broken off, you get 5. Multiply the false breadth with 5, you get 2,30.

Break 2,30 in two : 1,15. Square 1,15, (you get) : 1,33,45. Add it to 3,7,30,0, (you get) 3,9,3,45. Of what is it the square? It is the square of 13,45. Add to it 1,15, that you have squared, you get 15,0. Unravel the reciprocal of 30,0, the false area : 0;0,2. Multiply 15,0 with 0;0,2 : 0;30 is the original (length) of the reed."

MKT, I, p. 311-14.

" I got a reed. I know not its measure. I broke off from it one cubit. 1 time sixty in length I walked. I restored to it what I have broken off. 30 times of it I walked as length. The area is 6,15. What is the breadth of the reed? You in your operations take 1,0 and 30. For the reed that you do not know take 1. Multiply with it the 1,0, its sixty, that you walked, and 1,0 is the length of the GÌR. Multiply this 1 with 30;30 is the breadth of the GÌR. Multiply 30, the breadth of the GÌR, with 1,0, the length of the GÌR. 30,0 is the area of the GÌR. Multiply 30,0 with 6,15, the final area, and you get 3,7,30,0. Multiply 0;5, that was deducted, with the length of the GÌR, you get 5. Multiply 5 with the breadth of the GÌR, you get 2,30.

Break off 1/2 from 2,30, it is 1,15. 1,15 squared is 1,33,45. Added to 3,7,30,0 it is 3,9,3,45. What is the square-root? 13,45 is the square-root. Add to it 1,15, that you squared, you get 15,0. Form the reciprocal of 30,0, the area of the GÌR, it is 0;0,2. Multiply 0;0,2 with 15,0. 0;30 is the breadth of the reed.

The text and the subsequent interpretation of N. are rather confusing, and the results given in his commentary (length = 60; breadth = 6 1/4) are wrong. According to the interpretation of TH. D. the procedure of the Babylonian mathematician is correct and elegant :

A measuring rod of unknown size was used to measure the length and breadth of a field. One cubit (= 5/60 of a *ninda*) was

(6) I would prefer to translate " measure " with N. " Dimension " sounds too academic. The root of *mi-in-da* = מדה meant originally " stretching," but later it signified " measure "; cf. my paper " Die Harpedonapten," in *Quellen und Studien zur Gesch. d. Mathematik* B, I, 1930, p. 266.

(7) For the method used in the transcription of the Babylonian numerals, see the subsequent paragraph.

broken off from the rod, and the length of the field contained 60 times the shortened rod. Thereupon the cubit was restored to the rod, and the breadth of the field contained 30 times of the restored, complete, rod. The area of the field is 375.

The text says : assume the unknown rod to be 1. (We would say : x). Hence we have :

$l = 60\,(x - 5/60)$; $b = 30\,x$; $A = l\,b = 30\,x \,.\, 60\,(x - 5/60) = 375$

$30\,x\,(60\,x - 5) = 375$; $1800\,x^2 - 150\,x = 375$.

Take $(1800\,x)^2 - 150 \,.\, 1800\,x = 375 \,.\, 1800$.

$1800\,x = \sqrt{75^2 + 375 \,.\, 1800} + 75 = 825 + 75 = 900$; $x = \frac{1}{2}$.

The measuring rod was $\frac{1}{2}$ *ninda* = 6 cubits; l = 25 *ninda*; b = 15 *ninda*. Very important is the method of false position, which is employed here, and the light that it sheds on the parallel method of DIOPHANTUS.

§ 5. — *Babylonian Numerals. The Sexagesimal System*

In the discussion of the Babylonian system of numerical notation, we shall again have to consider the two aspects of the transcription, or method of presentation, on the one hand, and of the interpretation, on the other hand. In order to understand the numerals given in the text of no. 189, above, one must be familiar with the sexagesimal system of the Babylonian notation and with the method of its presentation, about which N. and TH. D. disagree.

N. adapts the method of the decimal system to the sexagesimal notation of the Babylonians. But, inasmuch as the sexagesimal system makes it possible for two digits to occur in one order, he had to introduce the comma (,), in order to separate from each other the different orders, so-to-say the columns of the Babylonian abacus. The semicolon (;) segregates the fractions from the integers, it represents the sexagesimal point, which, however, was entirely missing in the Babylonian system. Hence 6,15 is $6\,(60) + 15 = 375$; $1{,}0 = 1\,(60)$; $0;5 = 5/60 = 1/12$; $3{,}7{,}30{,}0 = 3\,(60^3) + 7\,(60^2) + 30\,(60) = 675{,}000$; $30{,}0 = 30\,(60) = 1800$; $15{,}0 = 15\,(60) = 900$; $0;0{,}2 = 2\,(1/60^2) = 1/1800$, etc. TH. D. introduces special symbols for each order among the integers as well as among the fractions. The following table may serve as an illustration :

Babylonian numerals	Transcription of N.	Th. D.	Our numerals
6 15	6,15	6` 15	375
1	1,0	1`	60
5	0;5	5′	$\frac{5}{60} = \frac{1}{12}$
3 7 30	3,7,30,0	3‴ 7″ 30`	675000
30	30,0	30`	1800
15	15,0	15`	900
2	0;0,2	2″	$\frac{2}{60^2} = \frac{1}{1800}$
1 30	1;30	1° 30′	$1\frac{1}{2}$

In the reviewer's opinion, the transcription of Th. D., though based upon some historical models of the Middle Ages, does not recommend itself for imitation. In the first place, Th. D.'s method, creating three different classes of symbols and providing each digit with its special symbol, indicating its absolute value and order, is violating the two most fundamental principles of the Babylonian as well as our modern notation, which are : (1) the relative place-value, and (2) complete numerical monism, rejecting any symbolical distinction between the orders in general, and between the three classes of units, decimals and fractions in particular. In addition to that, it is also inexpedient, giving rise to typographical difficulties and to some misunderstandings, as for instance in the transcription of astronomical texts (8). Therefore, the reviewer adopted N.'s method of transcription.

The Babylonian system of notation, though displaying great genius, is far from being perfect. It remained a torso, obscure and ambiguous, admitting of different, even contradictory interpretations. Thus, for instance, the fraction $2/60^2 = 1/1800$ is simply written 2, and we have to find out by the context that it means 0;0,2. As a rule, the zero is missing, even in the middle of the number, and the absolute value of the digits is never indicated. By way of illustration, let us assume that in our decimal system the zero and the decimal point, separating the

(8) Cf. N. in MKT, I, p. VII, note 5.

fractions from the integers, would be missing. Hence the number 3 could be read as 30, or 300, or 3000, or also as 0.3, or 0.03 etc. Similarly, the number 3568 could be understood as 35.68, or 3.568, or also as 3568. This is the great deficiency and shortcoming of the Babylonian system of notation (9). As a rule, we are in a position to establish the absolute value of the numbers beyond any doubt. But there are several cases in which we are not so sure, and these cases form the *crux* of the commentators. One such case is the calculation of the daily pensum of work by the Babylonian labourer, as given in TMB, no. 45, lines 9-11; MKT, I, pp. 142, 152, lines 9-11. The Babylonian text has the numerals : 10, its reciprocal 6; 6 times 50 = 5; the reciprocal of 5 is 12; 12 times 10 = 2. The different interpretations given by N. and TH. D. are as follows :

Babylonian text	N.	TH. D.
10, its reciprocal is 6	$10 = 10;\ 6 = 0;6 = \frac{1}{10}$	$10 = 0;10 = \frac{1}{6};\ 6 = 6$
6 times 50 = 5	$\frac{1}{10}$ times 50 = 5	6 times 50 = 5,0 = 300
reciprocal of 5 is 12	rec. of $5 = 0;12 = \frac{1}{5}$	rec. of 300 is $0;0,12 = \frac{12}{60^2} = \frac{1}{300}$
12 times 10 = 2	0;12 times 10 = 2	$0;0,12$ times $10 = 0;2 = \frac{2}{60} = \frac{1}{30}$

The reviewer is inclined to accept the interpretation of TH. D.

§ 6. — *Angle-Geometry*

The Babylonians had excellent ideas, but they were slow in their elaboration; they had wonderful formulae, which remained poorly formulated. We have seen that their system of notation betrays genius and deep insight, but it remained a torso without the zero, and obscure without the fixation of the absolute value. The same is the case with so many of their formulae. Concise and epigrammatic, lacking in motivation and mathematical foundation, they often remain obscure and ambiguous like the sibylline

(9) TH. D., in his *Esquisse d'une histoire du Système Sexagésimal*, Paris, 1932, p. 79, sees in this peculiarity not a blemish but a deliberate device, designed to create for the purposes of mathematical calculation an instrument of unlimited elasticity. But I am unable to follow him in that.

utterances and oracles. We had occasion to make this observation with respect to the formulae for the solution of the quadratic equations (10), and we shall find it corroborated by some formulae concerning the geometry of the circle. At the same time it will be demonstrated how important it is to approach these mathematical questions also from the philological point of view.

While discussing the ratio of the slope (11), N. usually speaks of the angle of the slope and, since the ratio of the slope is calculated as *b:h*, he calls it ctg *α*, or the ctg. of the angle of the slope. In dealing with the problems of TMB, nos. 64-65 (in MKT, I, p. 180), N. says: "In these two problems use is made of the Pythagorean Theorem and of the fact that the angle in the semicircle is a right angle." Upon the basis of this statement, R. C. ARCHIBALD announces that "the Babylonians of 2000 B.C. knew that the angle in a semicircle was a right angle, a result until recently attributed to THALES OF MILETUS" (12).

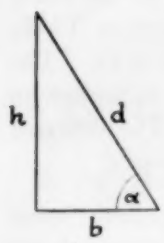

FIG. 1.

However, as early as 1929, the writer published in *Isis* XII, pp. 452-481, an article under the title "The Origin of Angle-Geometry," in which the clear statement was made that the ancient Egyptians and Babylonians had no geometry of angles at all, and that ***not even the term for the conception of an angle was known to them.*** The statement there (pp. 458-9, 461-2) reads as follows: "There is no mention made of a theory of angles or of a mensuration of angles in Egyptian or Babylonian mathematics. There are even no terms for right and oblique angles, and the alleged Egyptian word for the angle, *knbt*, seems rather to signify a corner or gate and not an angle as a measurable quantity in the modern or Greek sense of the word"... "Apart from this, such concepts as the center and radius of a circle were entirely unknown to the Egyptians, Babylonians and Hebrews. They had no words for them." My statement about the Egyptian

(10) See QE, pp. 410-417.

(11) See MKT, I, p. 170-71; TMB, no. 48; my paper "Indeterminate Analysis in Babylonian Mathematics," *Osiris*, note 11.

(12) See *Isis* XXVI (1936), p. 79, and cf. also *The Mathematics Teacher* XXIX, p. 215.

ignorance of the angles was confirmed by the late A. B. CHACE, the author of the American edition of the *Rhind Mathematical Papyrus*, who wrote in a private letter quoted *loc. cit.*: "I do not think that they (the Egyptians) had any conception of an angle as a thing to be measured, and it may be not even of one angle as being larger or smaller than another." What I said concerning the Babylonians is now being corroborated by TH. D., who says in the introduction to his TMB, p. XVII: "They (the Babylonians) had no term to express the idea of an angle. The inclination of a wall or of a slope is never defined by the angle which this wall or slope forms with the horizontal plane. One only says that the *ukullû* or 'fruit' is such and such per cubit of the height."

Literally, *ukullû* means "the eating" (13) and it refers to the amount of space which the inclined beam or diagonal "eats up," occupies, from the ground floor. The phrase "to eat space" in the meaning of "to occupy space" occurs pretty frequently in the Mishnah and Talmud (14). Thus we read there (*Kil'ayim* II, 10) אכלת הגפן והקבר והסלע The rather rare and archaic form *okhlath* seems to have preserved the old Babylonian form *ukullû*, and means "the eating of the vine, the grave and the rock," which has the sense: "the space occupied by the vine-roots, the space into which the roots of the vine extend," etc. Similarly in the other passages we read: "four cubits must *eat* from the dominion of Tiberias," which means, "must enter, extend into the area of Tiberias." Or, the question is asked: כמה לוחות אוכלות בארון "How much space did the holy tablets *eat* in the ark?" In the Mishnah, however, the term has never the meaning of a "ratio." This latter, technical, meaning was given to the term in the mathematical schools of the Babylonians.

The Babylonians observed and knew that if a pillar or beam is set up in an upright position along a wall, it reaches a height in the wall which is equal to its own length or height. But if it is leaned against the wall in an inclined, diagonal position, then it does not reach the same height in the wall, but, in

(13) See TMB, p. 215.

(14) See Mishnah *Kil'ayim* II, 10; *Middoth* III, 1; *Oholoth* XIV, 4; Tosephtha, *ibid.* XI, 1; XIII, 9; Palestinian Talmud, *Kil'ayim* 28*a*; *Erubin* IV, folio 21*d*, at the bottom; Babylonian Talmud, *Baba Bathra*, 14*a*.

compensation, it "eats up," occupies some space on the horizontal plane. The less it "eats," the taller and higher is it; the more it indulges in eating, the smaller is its height and the greater its embonpoint. Hence they investigated in their schools how much the inclined beam, or diagonal, loses in height, h, if it eats up a certain space, b, on the ground, and how far it would extend horizontally, if it loses a certain size of its height. These are the two problems in TMB, nos. 85 and 129, and these are the two oldest Babylonian examples of the Pythagorean theorem (15), which was very familiar to the Babylonians as early as 2000 B.C., but only in the form that in each *upright trilateral*, no matter how much inclined the hypotenuse may be, it always remains $d^2 = b^2 + h^2$. But they never refer to anything like angles, nor, of course, to right or oblique angles. In the above quoted paper (pp. 466-69), the problem of the Pythagorean theorem, in its prehistoric, oriental phase, was discussed at great length. And the conclusion was reached (on p. 480) that we have to distinguish a geometry of lines and a geometry of angles, representing two stages in the evolution of geometry. That the old Egyptian and Babylonian geometry must be characterized as a geometry of lines, and that the invention of the geometry of angles must be credited to the Greeks. So far, no facts have come to my knowledge which would contradict this theory, and with respect to Babylonian mathematics it is now being corroborated by the researches of TH. D.

Having thus established the fact that the Babylonians knew of no angles nor of any terms for angles, we cannot possibly explain their procedure as based upon the knowledge of the theorem of THALES about the right angle in the semicircle. In the following, I shall, therefore, give a discussion and new interpretation of TMB, nos. 64-5, dealing with problems of the segment.

§ 7. — *The Geometry of the Circle*

TMB, nos. 64-65; MKT, I, pp. 159-60, 180.

No. 64. Given is a circle and its segment : c = circumference of the circle; d = diameter; s = the chord of the segment; a = the arrow or height.

(15) See RA, vol. 32, p. 13.

Given are : $c = 60$; (hence $d = 20$); $a = 2$; to find s? The text figures according to

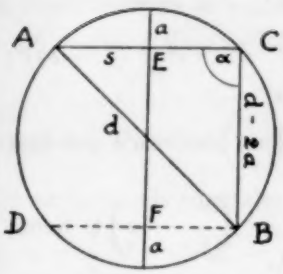

FIG. 2.

Formula 1 : $s = \sqrt{d^2 - (d - 2a)^2}$
$= \sqrt{400 - 256} = 12.$

No. 65. Given are : $c = 60$; (hence $d = 20$); $s = 12$; to find a? The text figures according to

Formula 2 : $a = \frac{1}{2}\left(d - \sqrt{d^2 - s^2}\right)$
$= \frac{1}{2}\left(20 - \sqrt{20^2 - 12^2}\right)$
$= \frac{1}{2}\left(20 - 16\right) = 2$ (16).

The derivation of the two formulae is given by N. as follows :

(1) The Pythagorean theorem.

(2) Angle α, being an angle in the semicircle, is a right angle.

(3) It seems to be tacitly assumed by N. that the Babylonian mathematician knew that, in figure 2, $BC = d - 2a$, for it is a parallel to $EF = d - 2a$. Hence it follows :

$$AC = \sqrt{AB^2 - BC^2};\ s = \sqrt{d^2 - (d - 2a)^2}.$$

According to N. formula 2 must have been gotten from formula 1. Since $\sqrt{d^2 - s^2} = d - 2a$; $2a = d - \sqrt{d^2 - s^2}$; $a = \frac{1}{2}(d - \sqrt{d^2 - s^2})$.

I regard this derivation as highly improbable. The Babylonians had no knowledge of the theorem of the right angle in the semicircle, nor can I see, nor does N. betray, by what means they got the knowledge of premise (3). In my opinion, the only plausible way of explanation is that they had first obtained formula 2 in about the following manner : In the rectangular triangle, figure 3, we have

$$BO = \frac{d}{2} - a;\ BO = \sqrt{AO^2 - AB^2};$$

$$\frac{d}{2} - a = \sqrt{\left(\frac{d}{2}\right)^2 - \left(\frac{s}{2}\right)^2}$$
$$= \frac{1}{2}\sqrt{d^2 - s^2}.$$

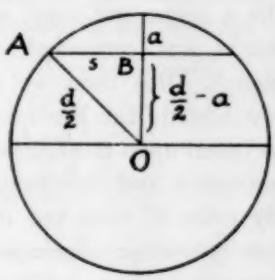

FIG. 3.

(16) There occur a few slips or errors of the scribe, which were corrected by TH. D. and N.

Hence $a = \frac{d}{2} - \frac{1}{2}\sqrt{d^2 - s^2} = \frac{1}{2}(d - \sqrt{d^2 - s^2})$.

From formula 2 the derivation of formula 1 is easy.

$$a = \frac{1}{2}(d - \sqrt{d^2 - s^2});\ d - 2a = \sqrt{d^2 - s^2};\ d^2 - s^2 = (d - 2a)^2;$$

$$s^2 = d^2 - (d - 2a)^2.$$

There is also, of course, the other possibility that they got first formula 1, as follows :

In figure 3 we have $\left(\frac{s}{2}\right)^2 = \left(\frac{d}{2}\right)^2 - \left(\frac{d}{2} - a\right)^2$; hence

$$s^2 = d^2 - (d - 2a)^2.$$

All that the Babylonians needed for the development of these two formulae was the knowledge of the Pythagorean theorem and also the knowledge, gained by inspection, that the arrow a bisects s, forms a right angle with it and goes through the center. Or rather, to be consistent and exact, that it stands upright upon s and that its continuation bisects the circle and is identical with the diameter. For the Babylonians did not operate with angles nor with the center of a circle; they had no words for these conceptions. They never thought of a figure like figure 2, drawn by N., nor of the right angle in the semicircle, nor of the identity of the chord BC $= d - 2a$. The formulae were obtained from other more simple theorems through algebraic operations, which were very familiar to them, and it is only pure coincidence that formula 1 does at the same time express the relation of the sides d, $d - 2a$, s in the rectangular triangle of figure 2.

In a sense, we may, of course, also say that the theorem of THALES was contained in the Babylonian formula 1 like in a nutshell. But then we have to say, not that the Babylonians knew already the theorem of THALES but that the latter theorem was based upon the Babylonian formula and represented its further elaboration and development. The Babylonian formula was not only prior in time but it displays also the character of a much more primitive phase in mathematical thought, which is the geometry of lines. For the historian of mathematics the most important thing is to emphasize this historical process of growth and evolution, to show how the imposing structure of Greek mathematics was erected upon the foundation of Egyptian and Babylonian traditions.

From these two Babylonian formulae we may easily derive a third one, expressing d in terms of s and a. Thus we may get from formula 1 :

1) $s^2 = d^2 - (d - 2a)^2 = d^2 - d^2 + 4ad - 4a^2 = 4(ad - a^2)$;

$$\frac{s^2}{4} = ad - a^2;\ ad = \left(\frac{s}{2}\right)^2 + a^2;\ d = \frac{\left(\frac{s}{2}\right)^2 + a^2}{a} = \frac{\left(\frac{s}{2}\right)^2}{a} + a$$

The same result may also be gotten from formula 2 :

2) $a = \frac{1}{2}(d - \sqrt{d^2 - s^2})$; $2a = d - \sqrt{d^2 - s^2}$;

$d^2 - s^2 = (d - 2a)^2 = d^2 - 4ad + 4a^2$; $s^2 = 4(ad - a^2)$;

$$\left(\frac{s}{2}\right)^2 = ad - a^2;\ ad = \left(\frac{s}{2}\right)^2 + a^2;\ d = \frac{\left(\frac{s}{2}\right)^2}{a} + a.$$

We would now expect to find this latter formula, too, somewhere, but, so far, I have not been able to find it in Babylonian mathematics. However, in the first Hebrew geometry and in the first Arabic geometry of AL-KHUWĀRIZMĪ it is this very formula that appears in the treatment of the segment; it also reappears in early Hindu geometry (17). In the edition of the *Mishnat ha Middot*, p. 71, note 21, I expressed the belief that Hebrew and Hindu geometry must have a common origin which is unknown to us. This common source is now found to be in Babylonian mathematics. Hebrew and Hindu geometry are thus shown to have preserved a third formula, supplementing the two Babylonian formulae about the relations of the three quantities of the segment :

Formula 1 (Babylonian) : $s = \sqrt{d^2 - (d - 2a)^2}$.

Formula 2 (Babylonian) : $a = \frac{1}{2}(d - \sqrt{d^2 - s^2})$.

Formula 3 (Hebrew and Hindu): $d = \dfrac{\left(\frac{s}{2}\right)^2}{a} + a$.

The connection between Hebrew and Babylonian geometry is still more manifest when we consider the method of computation for the area of the segment. I am therefore subjoining here no. 73 which deals with the area of the segment.

(17) See my edition of the *Mishnat ha Middot*, Berlin 1932, V, 7, p. 51, note 32, and p. 71, § 5, note 21.

TMB, no. 73; MKT, I, p. 188-90.

N. gives a thorough analysis of the problem, but leaves it as an unsolved puzzle. The long discussion is concluded with the words : " I can find no key whatsoever to the solution of this problem." I believe to have found the solution with the help of the formula given in the first Hebrew geometry (18) for the area of the segment (19). Both the Babylonian and the Hebrew formulae are apparently based upon the same principle, presenting only minor variations in the form. The general principle, or method, of old Babylonian geometry, in dealing with the segment, was obviously to consider it as a semicircle, to apply to it rules which can be proven only for the semicircle.

Let us call : A = area; b = bow or arc; s = chord; a = arrow or height; r = radius; d = diameter; $\pi = 3$.

Then we have in the semicircle :

$$b = \frac{3d}{2};\ a = r;\ s = d = 2r;\ \text{hence } s = 2a;\ b = 3a;\ b - s = a;$$
$$a = b - s.$$

In our problem here are given : $b = 60$; $s = 50$: to find A? And the Babylonian procedure is to figure :

$$(b - s)\,s - \frac{(b - s)^2}{2} = 50 \text{ times } 10 - \frac{10^2}{2} = 500 - 50\,(20) = 450;$$
$$A = 450.$$

From what I have pointed out it is evident that $b - s$ is equal to a, the arrow or height of the segment (21). Therefore, the

(18) *Mishnat ha Middot*, II, 4, p. 25.

(19) The same solution was given by TH. D. in RA XXIX (1932), p. 26 f., but without the reference to the Hebrew geometry. I wrote the above discussion in the Summer of 1938, while abroad in Europe, far away from the libraries and having with me, in the beginning, only the MKT. I informed TH. D. that I found some solution of the problem, and he sent me, in his letter of the 27. July, 1938, the whole substance of his interpretation in RA. Monsieur THUREAU-DANGIN was also kind enough to send me at the same time to Trouville sur Mer the last proof-sheets of his TMB, a long time before the volume was published, thus considerably facilitating my work. I herewith desire to express my appreciation for his great courtesy and helpfulness.

(20) The text reads : " less 100," but N. and TH. D. agree that we have to correct it into " less 1/2 . 100."

(21) The text, in v. 4, has " 10 *pirkam šutamḫir*," meaning " square 10, the *pirkum*." TH. D. always translates the latter term as signifying " the chord." He is therefore compelled to complete here, in the way of interpretation, " square 10, the (difference between the arc and the) chord." In my opinion,

Babylonian formula for the area of the segment reads : $A = s \cdot a - \frac{a^2}{2}$. For the semicircle and for the value of $\pi = 3$, the formula is correct : $A = 2r \cdot r - \frac{r^2}{2} = \frac{3r^2}{2}$. And the Babylonians have simply applied the rule of the semicircle to all the segments.

The Hebrew formula for the area of the segment, as given in the *Mishnat ha Middot* II, 4, reads : $A = (s + a)\frac{a}{2} + \frac{1}{14}\left(\frac{a}{2}\right)^2$. I have shown (*ibid.*, p. 25, note 14) that $\frac{1}{14}\left(\frac{a}{2}\right)^2$ was the addition of HERO, intended to adapt the old rule to the more exact value of $\pi = 3\frac{1}{7}$. The old formula had only $(s + a) \cdot \frac{a}{2}$, and is found also in Chinese and Hindu mathematics, while the Romans (COLUMELLA) and the Hebrews adopted the Heronian formula. The old formula, in its Hebrew form, corresponds to the value $\pi = 3$ and is correct for the semicircle :

(1) Hebrew formula : $A = (s + a)\frac{a}{2} = (2r + r) \cdot \frac{r}{2} = \frac{3r^2}{2}$.

(2) Babylonian formula : $A = s \cdot a - \frac{a^2}{2} = 2r \cdot r - \frac{r^2}{2} = \frac{3r^2}{2}$.

We have thus established that both the Babylonian and the Hebrew formulae for the area of the segment are based on the same method, derived from the calculation of the area of the semicircle as $\frac{3r^2}{2}$. Its elements are :

(1) $a = b - s$; hence $b = s + a$.

(2) $\pi = 3$; b of the semicircle $= s + a = 2r + r = 3r$.

(3) $A = \frac{b \cdot a}{2}$; in the semicircle $= \frac{3r \cdot r}{2} = \frac{3r^2}{2}$. Which means :

(4) Segment and Semicircle are both regarded as triangles with the arc as the base, b, and the arrow, a, as the height.

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however, *pirkum* denotes any line tranversing the circle, and is to be translated here as " the arrow." More about it is reserved for another occasion.

III. — Conclusion

§ 8. — Thureau-Dangin, *the Interpreter of Babylonian Mathematics*

In this work of his, Th. D. reveals himself as the great expert in Assyriology, as the masterful interpreter of the old Babylonian texts, familiar with all their obscurities and peculiarities. In many passages which the reviewer originally regarded as hopelessly corrupted, a felicitous and ingenious idea of Th. D. removed all the difficulties and made all the corrections and emendations unnecessary. In addition to his philological mastery, Th. D. shows also great acumen and a sound judgment in things mathematical. But above all he is distinguished through his love of truth and his sound instinct for the detection of the truth.

The Dutch Oriental Society EX ORIENTE LUX has displayed good taste and wise discrimination in selecting this work of Th. D. to form the first volume in the series of its publications. In their Foreword, the editors who speak in the name of the Society express themselves about the author in the following words :

" Avec son acribie sans pareil et sa prudence rassurante il est un des savants à qui répugnent toutes les théories mal fondées, un de ceux qui continuent la vieille gloire d'exactitude et de bon goût de la philologie française. Ses œuvres équivalent à celles des archéologues français qui ont ouvert la Chaldée pour la science moderne faisant connaître, eux les premiers, la civilisation des Sumériens."

We may safely subscribe to each word of this judicious opinion and measured judgment. However, the old glory of French philology and exegesis is much older than the nineteenth century, in which French archaeologists have discovered the Babylonian antiquities and deciphered the Sumerian cuneiforms. In a year from now, the scholarly world of France is preparing to celebrate the 900th anniversary of a Franco-Jewish commentator who laid the foundation for the sound philological interpretation of the Bible. He flourished in Troyes, Champagne, from 1040 to 1105, and became famous under the name of Rashi, which is derived from the initials of Rabbi Solomon ben Isaac. The

characteristic features of RASHI and his work are brevity, clarity, modesty, a sincere love of truth and a sincere search for the truth, and therefore an intuitive sense for the discovery of the truth. The same qualities may also be discerned in the work of TH. D., and therefore he may perhaps properly be called the RASHI of Babylonian mathematics. However, the hope is herewith expressed that scholarly France and the learned Republic of Letters of the world will not wait another 900 years in order to do honor to THUREAU-DANGIN, who laid the foundation for the sound philological interpretation of Babylonian mathematics.

New York City. SOLOMON GANDZ.
December 1938.

Carnegie Institution of Washington. Division of historical research. Section of the History of science.

Twenty-first annual report for the period extending from July 1, 1938 to June 30, 1939 (Previous reports appeared in *Year Books* of the Carnegie Institution, no. 18 to 37, 1919 to 1938; the 12th and following also appeared in *Isis*, the latest in vol. 30, 89-94).

I. *Introduction to the History of Science.*—During the past year the Latin and Greek notes of vol. III, dealing with science and learning during the fourteenth century, have been completed, except a few which had to be postponed for various reasons. The end of the work is now in sight. If all goes well, the analytical stage will be over by the end of 1939; then the years 1940 and 1941 would be devoted respectively to the synthesis and to the printing and preparation of various tables and indices.

II. *Editing of Isis and Osiris.*—During the course of last year four numbers of *Isis* were published (78 to 81), forming vol. 29 and two thirds of vol. 30, plus vol. 5 of *Osiris* devoted to the longer memoirs. A total of 1,628 pages, illustrated with 15 plates, 93 figures, containing 43 memoirs, 32 shorter notes, 107 reviews and 2,570 bibliographic items. It is worthwhile noting that every memoir published in *Osiris* (eleven this year) is the subject of a separate analytical card issued by the Library of Congress. The same could not be done for *Isis* the contents of which are far too abundant.

In the editing of *Isis* and *Osiris*, proofreading and correspondence *ad hoc* I was efficiently helped by Dr. Pogo. Since his return from Washington to Cambridge at the end of November 1938, his coöperation has much increased, not only because proximity made it easier and suppressed the need of correspondence, but also because while he was in Washington much of his time was

devoted to Maya astronomical computations and to the correction of the proofs of Dr. MORLEY's *Inscriptions of Peten* (*Isis* 32).

III. *Lectures.*—Dr. SARTON gave a course of about 33 lectures, on the history of modern science (XVIIIth century and after), at Harvard University and also at Radcliffe College. He conducted a seminar on the study of the history of science attended by Harvard and Radcliffe graduates (23 meetings). He delivered five lectures, (1) Oct. 25. Transcendental history, Winthrop Club, Emerson Hall; (2) Nov. 9. Function of academies past and present, American Academy of Arts and Sciences, Boston; (3) Nov. 17. Science during the French Revolution, Carnegie Institution, Washington, D.C.; (4) Dec. 29. COMENIUS and BAYLE, History of Science Society, at annual meeting of the American Historical Association, Chicago; (5) Dec. 30. Oriental science, joint meeting of the History of Science Society and the American Oriental Society.

IV. *Personnel.*—The staff of this section was modified and improved in various ways. Dr. MARY CATHERINE WELBORN resigned in October. Dr. POGO came back from Washington at the end of November. Mr. I BERNARD COHEN was continued as a fellow and devoted much of his time to routine work of various kinds (arrangement of the library and portraits) and to the study of the history of the early determination of the speed of light and of the theories of light since NEWTON.

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— Query no. 74.—The mysterious arctic traveller of 1360, NICHOLAS OF LYNN? *Isis* 29, 98-99, 1938.

— Query no. 75.—RAFAELE CANACCI, Florentine algebraist of the fourteenth century. *Isis* 29, 99, 1938.
— Fifty-third Critical Bibliography of the history and philosophy of science and of the history of civilization (to end of January 1938—with special reference to sections 31 to 33). *Isis* 29, 204-300, 1938.
— Deuxième préface au volume vingt neuf. L'histoire de la science et l'organisation internationale. *Isis* 29, 311-25, 1938.
— Query no. 76.—The tradition of the optics of IBN AL-HAITHAM. *Isis* 29, 403-06, 2 fig., 1938.
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— The scientific literature transmitted through the Incunabula (An analysis and discussion illustrated with sixty facsimiles). *Osiris* 5, 41-245, 60 illus., 1938.
— The scientific basis of the history of science. Coöperation in Research, 465-81 Washington 1938.
— Preface to volume XXX. Ugly ducklings. *Isis* 30, 6-16, 1939.
— Carnegie Institution of Washington. Division of historical research. Section of the History of science. Twentieth annual report for the period extending from July 1, 1937 to June 30, 1938. *Isis* 30, 89-94, 1939.
— Fifty-fifth Critical Bibliography of the history and philosophy of science and of the history of civilization (to end of July 1938—with special reference to sections 50 to 58). *Isis* 30, 138-218 1939.
— Second preface to volume XXX. Iconographic honesty (Followed by a Bibliography of iconographic studies and a Note on altered portraits). *Isis* 30, 222-35, 1939.
— Fifty-sixth Critical Bibliography of the history and philosophy of science and the history of civilization (to November 1938—with special reference to B.C. centuries). *Isis* 30, 314-420, 1939.

It should be noted that reviews of books and shorter notes are not listed in this bibliography.

Notes and Correspondence

Answer to Query no. 80.—When was logarithmic paper first used? (*Isis* 30, 95-6, 1939.)

(1) Royal Society of London Catalogue of scientific papers 1800-1900. Subject index, vol. 1 : pure mathematics. Cambridge, 1908, page 41.

Logarithmic charts, scale lines (1). BOYS, C.V. *Nature*, Vol. 52 (1895), 272 ff.

Logarithmic coordinates. VINCENT, J.H. *British Association Report* (1898), 159 ff.

Logarithmic paper for engineers. SAUSSURE, R. DE. *La Revue scientifique de la France*, vol. 2 (1894), 743 ff.

(2) The slide rule. C. N. PICKWORTH. 10th ed. (1906). Manchester. adv. p. IV.

Logarithmic paper advertised by JOHN J. GRIFFIN & Sons, Kingsway London.

(3) Elementary practical mathematics. JOHN PERRY. MACMILLAN, London, 1913. p. 121.

'I may say that plotting log x and log y on squared paper is so often successful... that an old pupil of mine (Mr. HUMAN) induced a stationer to manufacture sheets of logarithmic paper.'

(4) NAPIER tercentenary celebration. Handbook of the exhibition. ED. E. M. HORSBURGH. Royal Society of Edinburgh, 1914. p. 283.

'In technical and scientific literature references are made here and there to logarithmically divided paper and to its use in isolated problems and investigations, but the remark is always added that such papers are not manufactured in quantity. It is true that till recently logarithmic paper was only produced and put on the market in small quantities, and was under these circumstances difficult to obtain, as exact knowledge of where to get it was lacking. Lately, however, the well-known firm

(1) C. V. BOYS, *Nature* 52, 272 (issue of July 18, 1895).

'The advantages of logarithmic plotting for certain classes of work have for some time been recognised, and now that, thanks to Mr. HUMAN, logarithmically ruled paper can be obtained ready made, the facility of such plotting is greatly increased...'

of CARL SCHLEICHER & SCHÜLL of Düren, Rheinland, has taken up the manufacture of logarithmically divided papers and placed them on the market.'

There follows a long article on the applications of such paper, but without any historical information.

Haileybury College,
Hertford, England.
21.3.1939. C. W. ADAMS.

Aristotle's theory of vision.—Apropos of ARISTOTLE's theory of vision, discussed in *Isis*, vol. 30, 72 (1939), it may be worth noting how an Aristotelian of the early seventeenth century read his Aristotle.

COSMUS ALAMANNUS (1559-1634) in his *Tertia Secundae Partis Summae Philosophiae* (Papiae, 1623) writes :

" Circa modum videndi variae fuerunt Philosophorum opiniones. Quidam enim, ut DEMOCRITUS et alii posuerunt visionem fieri per defluxum corporum a re visa ad oculum. Quae positio falsa est...

Alii ergo dicunt fieri visionem per extramissionem radiorum ab oculis, ut EMPEDOCLES et PLATO. Differunt tamen hi inter se. Nam EMPEDOCLES vult id, quod egreditur ab oculo, extendatur usque ad rem visam... Quod continet manifestam impossibilitatem...

Alia opinio est PLATONIS, qui posuit, quod lumen egrediens ab oculo non procedit usque ad rem, sed ad aliquod determinatum spatium, ubi scilicet cohaeret lumini exteriori, ratione cujus cohaerentiae fit visio. Verum et haec positio non probatur...

Unde cum Philosopho dicendum est, visionem consistere in receptione formae a re visibili oculo impressae, ut dictum est, non autem in extramissione radiorum ab oculis vel in defluxu corporum a re visa ad oculum." (Quaestio LXVI).

For ARISTOTLE's positive opinion, Father ALAMANNUS gives reference to the Philosopher's *De sensu*, chap. 2, and to SAINT THOMAS' *De sensu*, lect. 8. SAINT THOMAS says : " Melius est dicere quod visio fiat per hoc quod medium statim a principio moveatur a sensibili," which remark is his ' commentary ' on ARISTOTLE's *De sensu*, chap. 2, 440^{a} 17-19, which reads : " So that it were better to say that visual perception is due to a process set up by the perceived object in the medium between this object and the sensory organ." (Translation by J. I. BEARE, Oxford, 1908.)

ALAMANNUS raises an objection against himself in true Aquinian style; he objects : " Videtur quod visio fiat per extramissionem radiorum ab oculis ad rem visam. Dicit enim Philosophus (2 *de Coelo et Mundo text.* 48; c. 8), quod visus se extendens ad stellas fixas valde distantes tremit; sed hic tremor denotat multam extramissionem radiorum ab

oculis; ergo visio fit per talem extramissionem." And he replies : " Non ideo dicit Philosophus visum tremere, cum longe valde porrectus respicit ad stellas fixas, quia fiat extramittendo; nam id improbavit (*de Sensu et Sensibili* c. 2); sed quia in hujusmodi eadem ratio est, sive fiat visio extramittendo sive intus suscipiendo; ... Utitur autem modo loquendi, ac si visio fiat extramittendo, quia mathematici ita utuntur in suis demonstrationibus, et plures homines ita loquuntur; nominibus autem utendum ut plures, sicut ipse dicit in 2. *Topic.* (c. 2)."

ALAMANNUS takes ARISTOTLE's opinion in *De sensu* to be the Philosopher's definitive stand on the question of vision, presumably because the *De sensu* is among ARISTOTLE's later physical works. Its opening sentence refers to the *De anima*, which was promised in the *Meteorologica* (339^a 6-9), which begins by enumerating the questions already dealt with in the *Physica*, *De caelo*, and *De generatione et corruptione*.

Toronto, March 27, 1939. W. BURKE-GAFFNEY, S.J.

A story concerning Euler and Diderot.—There exists a story concerning EULER and DIDEROT, which is regularly repeated, and which is, in the version of CAJORI, as follows :

" The story goes that when the French philosopher DENIS DIDEROT paid a visit to the Russian Court, he conversed very freely and gave the younger members of the Court circle a good deal of lively atheism. Thereupon DIDEROT was informed that a learned mathematician was in possession of an algebraical demonstration of the existence of God, and would give it to him before all the Court, if he desired to hear it. DIDEROT consented. Then EULER advanced toward DIDEROT, and said gravely, and in a tone of perfect conviction : " Monsieur, $a + b^n/n = x$, donc Dieu existe : répondez ! " DIDEROT, to whom algebra was Hebrew, was embarrassed and disconcerted, while peals of laughter rose on all sides. He asked permission to return to France at once, which was granted " (F. CAJORI, *A History of Mathematics*, Macmillan, 2nd ed., 1919, p. 233).

The anecdote is repeated in SMITH's " History of Mathematics," HOGBEN's " Mathematics for the Million ", BELL's " Men of Mathematics ", sometimes with even more lurid details.

I was never able to appreciate the story, because in its silliness it runs counter to what we know of EULER and of DIDEROT. Could EULER really underestimate DIDEROT to such an extent as to try this childish practical joke on him ? Was DIDEROT, probably France's clearest thinker of the period and the editor of the " Encyclopédie ", afraid of some elementary algebra ? I took the trouble to chase the anecdote, and this is the result.

CAJORI and others quote as their source A. DE MORGAN, *Budget of*

Paradoxes (1872, pp. 250-251, also p. 474) who relates it substantially in the same form as CAJORI does. MORGAN refers to THIÉBAULT as his source. We find the story in D. THIÉBAULT, " Souvenirs de vingt ans de séjour à Berlin", Volume III, pp. 141-143 of the 1804 edition. D. THIÉBAULT (1733-1807) lived for a considerable time at the court of FREDERIC THE GREAT and relates his experiences, adding plenty of gossip. A contemporary (Marshal MOELLENDORFF, 1807) has praised the veracity of this book.

After having told how DIDEROT talked atheism at the court of Elisabeth in St. Petersburg (1774), THIÉBAULT continues :

" On avoit un soir annoncé au philosophe françois, qu'un philosophe russe, savant mathématicien, et membre distingué de l'académie, offroit de lui démontrer l'existence de Dieu, algébriquement et en pleine cour; que DIDEROT, ayant témoigné qu'il seroit bien aise d'entendre une démonstration semblable, à la réalité de laquelle au surplus il ne croyoit guères, on avoit pris jour et heure pour le satisfaire; que le moment étant venu, toute la cour présente, c.à.d., les hommes et surtout les jeunes gens, le philosophe russe s'étoit approché gravement du philosophe françois, et lui avoit dit du ton de la conviction : *Monsieur,* $\frac{a+b^n}{z} = x$; *donc Dieu existe : répondez*; que DIDEROT, voulant prouver la nullité et l'ineptie de cette prétendue preuve, mais ressentant malgré lui, l'embarras où l'on est d'abord lorsqu'on découvre chez les autres, le dessein de nous jouer, n'avoit pu échapper aux plaisanteries dont on étoit prêt à l'assaillir; que cette aventure lui en faisant craindre d'autres encore, il avoit témoigné peu de temps après le desir de retourner en France...

Je n'assure la vérité d'aucun de ces faits; je dis seulement que, dans le temps ils ont été débités et reçus comme vrais par les habitans du Nord."

DE MORGAN himself, relating the story, wrote : " DIDEROT gladly consented : though the name of the mathematician is not given, it was EULER " (p. 251). At another place he wrote : " The mathematician who is not named, was EULER." (p. 474). DE MORGAN did not explain why he was so sure about this fact and we are at liberty to ignore it.

THIÉBAULT's story, as the author himself asserts, needs not be true. It is, however, far more acceptable than DE MORGAN's paraphrase. EULER does not enter in it at all. DIDEROT saw through the practical joke without trouble, but was annoyed by the prospect of similar silly performances, and therefore went back to his country " peu de temps après "—and not even " at once ".

DIRK J. STRUIK.

Reviews

Pliny.—*Natural History.* With an English translation by H. RACKHAM in ten volumes. Vol. I. Praefatio. Libri I, II. XIV+378 p., Latin and English texts on facing pages. Loeb Classical Library No. 330. Cambridge, Mass.: Harvard University Press; London: WILLIAM HEINEMANN, Ltd., 1938. (Cloth $ 2.50; Leather $ 3.50.)

The original Latin text reprinted here is that of DETLEFSEN, Berlin, 1866, checked by the Teubner edition of LUDWIG VON JAN re-edited by MAYHOFF (1905, 1909, 1933). The manuscripts of PLINY's *Natural History*, which have been preserved, are numerous and among them none carries internal evidence of paramount authority, and few show agreement on doubtful points. The mass of technical detail and terminology contained in this encyclopedic work is so great that few copyists had sufficient erudition to avoid errors of transcription and some possibly lacked inhibitions which might prevent additions to the descriptions of the marvelous, for which the original author has incurred no little scorn for his credulity. These minor differences and discrepancies, and the seeming lack of critical inspection should not lead to the erroneous opinion that PLINY's great encyclopedia of learning of the classic period has little value. A casual scanning of the 72 pages of the table of contents of the 37 books of this first great encyclopedia suffices to establish the wide scope of the work, the numerous authorities cited, and the vast mass of details included. Most of the material readily passes critical scrutiny; at times PLINY himself rejects the tale he reports as incredible, and sometimes his tongue is in his cheek.

Science had its beginnings in man's interest in the marvelous and the unusual and PLINY was in at the start of natural history. We may explain the mermaid and the unicorn as coming from travelers' tales of the dugong and the rhinoceros, but when PLINY describes the " third sort " of bright thunderbolts that can drain a cask dry without damaging the lid and melt gold and silver without singeing the bags or melting the wax seals we must remember that sailors still can broach a cask of wine without starting the bung—believe it or not.

The value of PLINY's *Natural History* to modern science does not lie in its analytical qualities. While it is true that his work does not

exhibit refined, skilful, and well-balanced classification and organization of data, it is the first attempt at so general a classification of all objective data from the study of nature. The main groupings of his classification are still useful. He claims in his preface to deal with 20,000 matters of importance, drawn from 100 selected authors, with observations of his own added thereunto. His interest in the marvelous is evident and his utilization of the writings of others is inclusive rather than critical. The translator states that Pliny sometimes failed to understand his authority, and used the wrong Latin names for things dealt with by his authorities in Greek.

As one reads these first two books one understands why PLINY had the reputation of untiring industry. When one remembers that he had no trained secretary, no typewriter, no manuscript reader, and saw neither galley nor page proof, and that no one knows how many stories crept into this wonder book from the quills of sly but interested copycats, the greater seems PLINY's masterpiece. It has great historical value as a compilation of the scientific knowledge of classic times and a mirror of the attitude toward nature among the Romans when Rome was in her prime.

This first volume of the ten projected to encompass PLINY's great work contains the long and detailed table of contents, which constitutes Book I, and Book II, which deals with cosmology, astronomy, meteorology, and physical geography. "The world and this—whatever other name men have chosen to designate the sky whose vaulted roof encircles the universe, is fitly believed to be a deity, eternal, immeasurable, a being that never began to exist and never will perish. What is outside it does not concern men to explore and is not within the grasp of the human mind to guess. It is sacred, eternal, immeasurable, wholly within the whole, nay rather itself the whole, finite and resembling the infinite, certain of all things and resembling the uncertain, holding in its embrace all things that are without and within, at once the work of nature and nature herself." This opening paragraph exhibits both the modernity and lofty concepts of the author and the directness and simplicity of the translation.

This translation follows the original quite closely in form, and lacks the freedom of the Elizabethan English of HOLLAND's translation of 1601 and 1605. It is, however, a great improvement over the somewhat stilted and occasionally inaccurate translation of BOSTOCK and RILEY (1855-1857) in Bohn's Classical Library. The fact that these, the only English translations, are all but unobtainable makes this conveniently bound and correctly made translation of this great classic of natural history doubly welcome.

CHARLES A. KOFOID.

Joseph M. Millas Vallicrosa of Barcelona.—" RABBI ABRAHAM IBN EZRA's Work in Scientific Astronomy," *Tarbitz*, 9th year, parts 3-4, pp. 306-322, the Hebrew University, Jerusalem, 1938 (In Hebrew).

While IBN EZRA's works as a whole have been widely studied, his purely astronomical works have received far less attention than their importance warrants.

The only commonly known astronomical work of IBN EZRA is his Hebrew translation of an Arabic manual usually attributed to AL-BIRUNI. This work, which has survived only in the Hebrew translation, is entitled " *The Book Composed by* MUHAMMED AL-MATANI (ABENMUCENNE) IBN ABD EL-KRIM *on the Reasons of* AL-KHWARIZMI's *Tables*." It is couched in the form of question and answer, one character asking " Why did AL-KHWARIZMI say " so-and-so, quoting directly from AL-KHWARIZMI, while the other character explains the meaning of the phrase. Since the only other extant version of AL-KHWARIZMI is ADELARD OF BATH's Latin translation, which does not always agree with IBN EZRA's version, the latter thus affords an invaluable check on AL-KHWARIZMI's actual text.

Dr. MILLAS shows that the Arabic text translated by IBN EZRA can not have been written by AL-BIRUNI, to whom it is usually attributed (see HASKINS, *Studies in Mediaeval Science*, p. 14, Harvard University, 1924, and SARTON, *Introduction to the History of Science*, vol. II, p. 188), but must be associated with the heretofore unrecognized Moslem astronomer, AL-MATANI, mentioned in the title. Confirmation of this view is to be found in a second, hitherto unstudied astronomical text of IBN EZRA's, in which he refers directly to both AL-BIRUNI and AL-MATANI as separate individuals.

While this second text is often refered to in IBN EZRA's own works it was not until 1922 that BIRKENMAJER found fragmentary Latin manuscripts in Cracow and Paris. Since then MILLAS has found additional Latin versions in Toledo and Oxford. No Hebrew editions are known, and it is quite possible that the work was never written in that language, being dictated to some Christian student, who recorded it directly in Latin (an hypothesis born out by the actual style of the text).

This treatise is of great importance to the historian of astronomy because of its extensive critical and historical references to Greek, Egyptian, Hindu, and Moslem astronomers. The references to AL-ZARQALI and to the hitherto unknown AL-MATANI are of particular interest. It is this astronomical treatise, designed primarily as an exposition of the principles and rules followed in constructing astronomical tables, which contains the " *Tabulae Pisanae*." These tables illustrate excellently IBN EZRA's great knowledge of astronomy. They follow

AL-ZARQALI's tables, with emendations according to AL-SUFI and IBN-YUNUS. It is of particular interest to note that IBN EZRA rejected the pernicious concept of trepidation. The importance of the *Tabulae Pisanae* is shown not only by the number of Latin manuscripts now known but also by the fact that they were the main source of HENRY BATE's *Tabulae Machlinenses* and of the *London Tables* of 1232.

Dr. MILLAS gives a complete description of the contents of IBN EZRA's book—I note particularly that GMUNDEN and PEURBACH seem to have derived their trigonometrical knowledge from this book rather than directly from the Latin translations of AL-ZARQALI.

It is peculiarly unfortunate that this paper, which is of considerable importance to the Historian of Astronomy, should have been published in a language that is not widely known and in a journal of very limited circulation, but I note with pleasure that Dr. MILLAS promises to publish a critical edition of IBN EZRA's important treatise (if the civil and international wars do not put a stop to all such innocent activity).

Harvard College Observatory. DANIEL NORMAN.

Samuel Eliot Morison.—*The second voyage of Christopher Columbus from Cadiz to Hispaniola and the discovery of the Lesser Antilles.* 112 p., 4 maps. Oxford, Clarendon Press, 1939. ($2.50).

I took up with special alacrity this handsome little volume, for any book dealing with the West Indies has a strong claim on my heart and if it also concerns the history of science the claim is almost irresistible. The Caribbean Sea is often called the American Mediterranean ; that comparison is attractive yet deceiving in two ways. While the Mediterranean islands open up a historical panorama leading us back willy-nilly to the hoariest antiquity, the American islands have no history to speak of. Spain made very little account of them, at least of the Lesser Antilles, and their history reduces itself to three centuries of colonial warfare and barter. On the other hand, I do not hesitate to say that the *natural* beauty of the American islands is incomparably greater than that of the European ones. They are really little paradises, or they could have been paradises but for the greed and cruelty of men. No one whose privilege it has been to sojourn in some of them or to cruise among them can ever forget their surpassing loveliness, and he will return to them just as soon as he can.

MORISON's essay pleased me for another reason. The burden of it is that, in order to discuss intelligently maritime discoveries, book knowledge, however necessary, is utterly insufficient.

" Nor is it sufficient merely to view a coastline from the deck of a ship. Every

student of voyages should have sea experience and know what a seaman would do under given circumstances. That would save us from such absurdities as COLUMBUS' anchoring on a lee shore or in impossible depths, sending a boat ashore in the breakers on a rocky coast, and making a speed that would do credit to a modern ocean racer; all of which are common enough in Columbian literature. Opinions still differ as to whether or not COLUMBUS was a scientific navigator; but there can be no possible, probable shadow of doubt that he was a great seaman. And, starting from that premiss, we are safe in assuming that during his Caribbean voyages he would have sailed along the lee, that is the western, shores of the Lesser Antilles. 'It is not material,' says one writer, 'whether COLUMBUS sailed up the west or up the east side of the islands.' He would find it material enough if he tried! No seaman deliberately chooses foul weather when he may have fair, or rough water when he can find smooth. COLUMBUS quickly discovered the difference between the windward and leeward sides of the Lesser Antilles, and ascertained that only along the lee coasts could he safely approach near enough to inspect the land, or anchor, or send people ashore," (p. 4-5).

Now that is the very plea which I have been making all along with regard to the history of science. The historian who has no experimental and intimate knowledge of science, who has never worked in a real laboratory or handled instruments in the course of genuine, adventurous, investigations is always in danger of writing absurdities comparable to those of the stay-at-home geographer. Whenever knowledge is restricted to words and does not extend to the realities which those words symbolize, it is at the very best, pale and unconvincing, and more often than not, it is out of focus, the emphasis is wrongly placed, and the final picture false and misleading.

Therefore, we should be grateful to the distinguished Harvard historian (about whom see *Isis* 25, 513-20) for having left his comfortable study not far from mine in Harvard Library and sailed from Boston in the winter of 1937 in a small yawl to explore COLUMBUS' tracks and find out by personal experience his most probable landings.

I shall not attempt to describe the voyages of the Genoese seaman or of his Bostonian follower. Read the book itself; it is short and pleasant. Good maps enable one to understand the argument; a general map summarizes it, for upon it the most probable anchorages of COLUMBUS' fleet have been indicated, and the ten fathom line is everywhere indicated. We wish that the author who has already returned from a second navigation in the wake of the Great Admiral, may soon tell us another tale as breezy as this one. By the way, if the Admiralty and U. S. charts of the Caribbean are as faulty as suggested (on p. 2), it would be worth while to correct them. Now that soundings can be taken with relative speed and cheapness along continuous lines the U. S. Hydrographic Office should consider the preparation of new charts which might be of great value to the American Navy. GEORGE SARTON.

Jacob S. Minkin.—*Abarbanel.* VI+237 pp. New York : Behrman's Jewish Book House, 1938, ($2.50).

Don ISAAC ABARBANEL (1437?-1509?) who forms the subject of this book owes his fame among students of Jewish literature to the many commentaries which he wrote on the Bible. Distinguished by wide learning and a remarkable urbanity acquired from his prolonged contacts with princes and other men of the world these commentaries were read and continue to be read by all devout students of the Jewish Bible. In the seventeenth and eighteenth centuries ABARBANEL's were the most widely read of the Jewish commentaries among Christian theologians, and several of ABARBANEL's commentaries were actually translated into Latin. As Dr. MINKIN points out, ABARBANEL was not an original thinker, he was rather an assimilator of knowledge and a learned analytic mind who brought a vast amount of knowledge to bear upon the solution of Biblical problems. His mind was of the best mediaeval order, and being a profoundly religious man there was nothing in the Bible which he ever questioned, although he never feared to express himself in an unorthodox manner. In his interpretations he mixed pure rationalism, mysticism, symbolism, allegory, and the miraculous with wonderful ease. The beauty of his style has often been the subject of eulogy. In the present volume Dr. MINKIN presents the noble ABARBANEL against the background of his time in a book which should have a wide popular appeal. ABARBANEL's life was a very richly variegated one, full of honour and distinction, and as was that of many scores of thousands of his contemporary co-religionists, full of tragedy and suffering. Dr. MINKIN tells the story of the sufferings of the Jews and their expulsion from Spain with dignity and with restraint. It may be recalled here that it was ABARBANEL who, but for the fiendish TORQUEMADA, almost succeeded in persuading FERDINAND and ISABELLA not to issue the order of expulsion against the Jews. But it was not to be.

Shortly after his death the cemetery at Padua in which ABARBANEL was laid to rest was desecrated by the contending soldiery of the Venetian Republic and MAXIMILIAN I. Even in death his Christian fellows whom all his life he had served with affection and rare ability begrudged him more than an anonymous grave.

It may be that we are fools to think that men will ever allow their betters more.

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

Robert K. Merton.—*Science, Technology, and Society in Seventeenth Century England.* (*Osiris*, Volume IV, Part 2, Bruges 1938).

The purpose of this scholarly monograph is to prove that, to quote its

concluding words, " the cultural soil of the seventeenth century England was peculiarly fertile for the growth and spread of science." The method employed consists of an analysis of various social factors and values of the times, which are shown to have been unusually conducive to the development of science, and of economic activities which did much to determine the specific direction pursued by scientific investigators. Before, however, proceeding to his main object, Dr. MERTON, by a statistical study of nearly a thousand biographies recorded in the *D.N.B.* for this century, establishes what most students of the seventeenth century will readily concede, namely, that the period was one of remarkable interest in science. Examining the time at which each subject of these biographies first revealed interest in what became his life work, the author shows how as the century advances, interest in science rapidly increases while interest in other activities such as poetry, drama, and music declines. By further statistical analyses, Dr. MERTON makes plain how and at what time certain sciences assumed ascendancy over others, after recognizing and making due allowances for transient factors which produced temporary changes in the relative interest shown in the various sciences (1).

The social and cultural values to which the author ascribes the greatest importance are those contained in the religious movements of Protestantism, Pietism, and Puritanism, with especial emphasis upon the last. As he points out, within the last few years attention has been called in various articles and books to the close connection between science and the Puritans, and he himself in no small degree further clarifies and establishes this relationship, which should in a short time become almost a truism in the history of science (2). The two respects in which the author is interested in showing that Puritan theology found a sanction for science are the glorification of God through works, which he thinks were interpreted in terms of experiments, and the manifestation of God's attributes in nature. The latter idea was, of course, as old as the *Psalms* and as current as CICERO's philosophy, but science certainly gave it added significance, though it was by no means confined to the Puritans " (3).

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(1) One such factor, unnoticed by Dr. MERTON, is revealed in THOMAS BURNET's sensational *Sacred Theory of the Earth*, which appeared in Latin and English versions during the ninth decade of the century, and which undoubtedly accounts for the unusual increase of interest in sciences relating to the earth throughout the last decade.

(2) Clear evidence of this relationship, recently discovered by the reviewer, is revealed in a Puritan treatise entitled *Sundry Things from Several Hands concerning the University of Oxford*, 1639, which contains a proposal to turn Christ Church into an experimental scientific institution.

(3) Because the theological differences between Puritans and Anglicans were

The first idea is very interesting, through the reviewer feels that it should be worked out in greater detail, especially as regards direct evidence that " works " came to be equated with experiments. Two tentative objections to the idea that the Puritans integrated their science and theology suggest themselves. BACON, whose influence at this time was exceedingly great, clearly separated the two, and there is evidence that the Puritans followed him in this attitude. JOHN DURIE, one of the leaders in the educational reform of the Puritans, " maintains that since the application of natural principles to spiritual objects leads to endless confusion, the two worlds should be kept entirely separate, spiritual truths being discerned spiritually, and natural truths naturally," (4) and SPRAT says, " the Royal Society is abundantly cautious, not to intermeddle in *Spiritual things*," (5) though he felt compelled to answer charges of irreligion brought against the scientists. It is in this answer of SPRAT's that the second objection is found. Although he marshalls apparently all religious arguments in behalf of the new science, and expresses many Puritan values and attitudes, there is no mention made of the glorification of God through works, *i.e.*, experiments (6). Has it not been one of the weaknesses of Puritanism that it failed to integrate its materialistic and spiritual sides?

In the next few chapters, Dr. MERTON, by a comprehensive and critical use of modern economic treatises on the period, demonstrates that the development of economic activities such as mining and transportation, and uneconomic activities such as military science, inspired the scientists to solve the problems presented by them. A concluding chapter, which, perhaps, would have found a more natural place earlier in the volume, comprehends discussions of various social and cultural factors which assisted in the advancement of science. One, belief in progress, seems to the reviewer to have been rather a result than a cause of scientific progress, though, of course, when once inspired it furnished a strong motive for the support of science.

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slight, the author makes no attempt to distinguish between them in his discussions, but certain distinctions as regards values other than theological should be made. Puritan divines like WILKINS and TILLOTSON later became " Latitudinarian " Anglicans, and carried over into their new position the attitudes of Puritan science, and other divines like BARROW, who possessed no Puritan background, through association with science developed similar attitudes; but there was a great and significant difference between naturalistic Puritans and humanistic Anglicans, a difference which frequently resulted in sharp controversy, and which helps to explain the humanistic nature of neo-classical literature.

(4) RICHARD F. JONES, *Ancients and Moderns*, p. 96.

(5) *History of the Royal Society*, 1667, p. 347.

(6) *Ibid.*, pp. 345-378.

In general, this important treatise is conspicuously characterized by the true spirit and method of conscientious scholarship. Critical in attitude and cautious in statement, the author gathers his evidence from wide sources, and brings it to a logical focus on the problems of his subject.
(*Washington University.*) RICHARD F. JONES.

R. T. Gunther.—*The life and work of Robert Hooke.* (Part V) *Micrographia*, 1665. Early science in Oxford, vol. 13, x + (36) + 273 p., 38 pls. Oxford : Printed for the subscribers, 1938.

This is a reproduction by the Replika process of HOOKE's immortal work which opened up a new world to the eyes of men. It is a facsimile edition which faithfully reproduces every detail of the original. The printed text in the original edition measures 8-3/4 by 5 inches. As reproduced it approximately is 6-1/4 by 3-3/4 inches, and, though the heavy-bodied type quite fills the lines, the text is still sufficiently legible to be read though their crowding makes them somewhat difficult to follow.

A second edition was called for two years after the first and thirty-three of the thirty-eight plates were reissued with abbreviated letterpress in 1745 and again in 1780 under the title *Micrographia Restaurata*. The International Organization for Intellectual Cooperation at its last meeting at Prague advocated a reissue of this masterpiece by the English father of microscopy and the edition of *The life and work of Robert Hooke* has made it the fifth volume of the series. GUNTHER has added a brief introduction which reviews the significance of the microscope in the history of science and medicine. He also lists HOOKE's dated contributions to the Royal Society which reveal that when he exhibited his model microscope to the Society he was solicited to prosecute his microscopical observations in order to publish them and later on March 25, 1663, was urged to bring to every meeting at least one observation. This he proceeded to do, presenting in sequence many of the observations recorded and illustrated in the *Micrographia*. On July 6th he was ordered to show King CHARLES II his observations in a handsome book provided for the purpose. On November 23rd, 1664 the President was desired to sign a licence for the printing of Mr. HOOKE's microscopical book, which according to a letter from HOOKE to BOYLE had been printed off before October 24th. The delay was due to the several members of the Society who read the sheets.

A review appeared in the *Philosophical Transactions* for April, 1665. But the universally curious Mr. PEPYS, who is known to have had a microscope of his own at the Navy office, was earlier in the field for on the 20th of January, 1665, he went to his booksellers " and there took home HOOK's book of microscopy, a most excellent piece, and of which I am very proud."

HOOKE's *Micrographia* is not limited to observations on the curiosities of the microscope. It contains his views on combustion; conceives heat to be a mode of motion, and light a short vibrative motion transverse to straight lines of propagation, notes interference colors in soap bubbles, NEWTON's rings, the ascent of liquids in capillary tubes, the invention of the microscope, hygrometer, and wheel barometer. He even discusses the possibility of producing artificial silk

CHARLES A. KOFOID.

Léo Pierre Courtines.—*Bayle's relations with England and the English.* XI + 253 p. New York, Columbia University Press, 1938 ($ 3.50).

The department of history of Columbia University deserves our gratitude because of the many studies it has devoted to these subjects of fundamental importance : the freedom of thought and the dignity of man. Such studies are more important than ever but unfortunately are not available in the countries where they are most needed.

We owe to Columbia at least three valuable works on PIERRE BAYLE (1647-1706), to wit, two by HOWARD ROBINSON : *The great comet of* 1680. *A study in the history of rationalism* (Columbia Ph. D. thesis, 127 p., 1916) and *Bayle the sceptic* (354 p., 1931), and the book now under review.

One knows that BAYLE spent the whole of his creative life (1681-1706) in Rotterdam, where contacts with England were close and incessant, especially after the accession of WILLIAM OF ORANGE in 1689. He was thus well located in that city to obtain a good knowledge of English affairs, that is, as good a knowledge as was available to a man who never visited England and did not know the English language. Nevertheless it was possible for BAYLE not only to read books about England, but to talk with Englishmen in Latin or French, or to discuss English matters with French refugees. Even as German barbarism obliges now thousands of German citizens to find new homes abroad, French cruelty drove then thousands of the best citizens of France into exile. The Protestant emigration increased considerably after LOUIS XIV had edicted that the abjuration of Protestantism by seven-year old children was permanent. The Protestants were afraid of losing their children. We can realize their fears more vividly in the light of similar events happening as it were under our own eyes in Germany, Russia, and Italy, for to steal the souls of children is considered a legitimate exercise of government in those regions.

BAYLE had the best of reasons to want information on the affairs of England, where kings had tried to change the religion of their people four times in less than thirty years ! The contemplation of those extraordinary events helped him to understand those of France.

"He knew from his historical studies and personal observations that, unfortunately, tolerance and justice were no more on the side of the Protestants than on that of the Catholics and that both parties were equally guilty of acts of which an unbiased individual could very well be ashamed. His primary interest in calling attention to inconsistencies in the tenets, professed ideals, and actual performances of leaders of both religions was to instill in both parties a salutary doubt as to the veracity and divinity of their professions of faith and purity of intentions." (p. 23). "England's troubled political and religious life supplied BAYLE with excellent arguments with which to refute his opponents in Holland, in France, and elsewhere on the Continent. Incidentally, without conscious efforts at propaganda he made England and its institutions better known to the rest of the occidental world, thereby helping to make things English fashionable and ushering into French life that admiration for England which was to exercise a great influence." (p. 25). "To show that tolerance was no more to be found among Protestants than among Catholics, BAYLE reminds his readers that when Geneva accepted Protestantism, all those who refused to renounce Catholicism were asked to leave the city. He gives information on the treatment of dissenters in Swiss cantons, in Sweden, and in England, stressing the fact that England, not content with banishing those of her subjects who became Catholics, went so far as to have them put to death. He recalls that it had been agreed in England and in Scotland that being a king was incompatible with Catholicism and that, therefore, a Catholic king was condemned to banishment, or to a punishment worse than exile could be to any subject." (p. 26).

BAYLE was a genuine defender of toleration, the first and perhaps the greatest, more thorough than his contemporary LOCKE. He understood deeply from the beginning that toleration is meaningless, if it is claimed only for one's self, for one's own group (as most people do naturally enough); it must be extended to one's contradictors and one's enemies. It is from that point of view that BAYLE's activities are significant in the history of science. He was not a scientist and was not even "unusually" interested in science, as the author wrongly says (p. 96). On the contrary, his understanding of science and interest in it were equally mediocre. He corresponded with BOYLE, SLOANE, BURNET and others but that proves nothing. Yet he prepared the ground for the scientific work of the eighteenth century by his continual insistence on disinterested criticism in the search of truth.

The most valuable feature of COURTINES' book is a list of English references in the *Œuvres diverses* (4 vols., 1727-31), another of Englishmen found in the 1697 edition of the *Dictionnaire*, supplemented by the 1720 edition, and a third one of English references in articles and remarks found in the 1697 edition of the *Dictionnaire*. It is a pity that these three indices were not merged into one. The synthetic part of the book is not quite as good as the analytical part; it is repetitious and lacks depth.

Nevertheless, the author has done well what he had set himself to do, and the usefulness of his work extends beyond the limits of his investi-

gations. He has invited us to turn our minds again to PIERRE BAYLE, a great man, whose wisdom is as needed in our time as it was at the end of the seventeenth century.

GEORGE SARTON.

Herbert of Cherbury (1583-1648).—*De veritate:* first published in Paris, 1624. Translated with an introduction by MEYRICK H. CARRÉ. Published for the University of Bristol by J. W. ARROWSMITH, Bristol, England, 1937.

EDWARD HERBERT, EDWARD, LORD HERBERT OF CHERBURY, presents in his thought as well as in his person the equivocal temper of an uneasy transition period. His is the age known to us in poetry through his brother, GEORGE HERBERT, and through his mother's friend, JOHN DONNE. A man of that time should live chameleonic, and HERBERT did. He boasted that until his fortieth year he led the superficial life of a courtier, soldier—more or less—of fortune, dilettant at letters, continental traveler and exquisite. He betrays in his autobiography more satisfaction in the life of those six years during which he was ambassador of the first JAMES to the Court of France than in the works of his pen. Yet, in the end of all, cut off from favor for a quarter century, a failure at intrigue no less than FRANCIS BACON, his senior, and THOMAS HOBBES, his junior contemporary, he had it written on his tombstone only that he wrote *De Veritate*.

Philosophy in the second half of the sixteenth century has ceased to live within the limitations of the Schools. The wars and plagues and uninspired routine of three centuries have darkened the interval between this secular dawn and that first twelfth-century enlightenment. Now "the Schools may no longer impose upon us." Now HOBBES, BACON, DESCARTES, SPINOZA do the thing which has never been done before. Much store is set upon originality and new method. In self-estimation HERBERT says: "I believe myself to be the first to describe the sphere of all the faculties of man." (p. 234.) Not priests but scientists are now philosophers. The age of discovery and gold and reformation must have new learning too. But though new learning speaks in English and in French, it still must write in Latin. THOMAS MARSTON, hack, in Lord HERBERT's service, is the "Latinizer" of *De Veritate*!

The Theory of Knowledge.—The problem of establishing a new method for philosophy involves that of the criteria of truth. Is truth the passive conformity of a knowing mind to an object; is truth the subjection of an object to the conditions and structure of a knowing mind; is truth a harmony of natures preëstablished in both the knowing mind and the object? The first view is that of Empiricism from Lord BACON

to HUME. The second is the Kantian view. The last—the view held by HERBERT against the prevailing Empiricism of his countrymen—more nearly represents the mean of scholastic realism than either of the alternatives.

(Faculties.) HERBERT's theory of knowledge begins with the supposition of a multitude of distinct mental Faculties corresponding, in the knowing nature, to an analogous multitude of types of object in the nature to be known. " The whole of my doctrine of truth is based upon the proper conformity of the faculties with their objects." (p. 80.) A faculty is a mode of action, since the mind is by its nature active, rather than acted upon. The existence of a faculty is sufficient warrant for the existence of objects preformed to its special mode of activity. In the conformity of faculty to objects which establishes the relation of true knowledge the mind is not a *tabula rasa*, nor is the object an agent; objects " do not act upon our mind but are drawn into its influence." (p. 175.) The object of knowledge is a stimulus to a formed activity latent in the knowing mind, and this latent formed activity *is* a faculty. And " the faculties can only properly conform with objects with which they have special affinity." (p. 104.) Error is to be attributed to mistaken attempts to establish conformity between faculty and object where no preëstablished " Analogy " exists between them.

The complex differentiations in Nature, caused by a multitude of " principles of individuation "—(HERBERT employs this scholastic phrase in a somewhat disconcerting plural)—, are reflected in the whole microcosmic complex of Faculties. Should one protest that this is to attribute a very intricate psychological anatomy to man, HERBERT is prepared to reply—" You see what an advance we have made over the Schoolmen, how complicated man really is ! "

There is a similarity worth noting between the view here presented of a one-to-one correspondence between Faculties and objects and the view of the modern German Phänomenologie since BRENTANO. Here too there is a one-to-one correspondence between " intentional acts " and objects, and here too a survey of the innate cognitive activities is received as token for a survey of existing objects.

(Common Notions.) The dominant theme of HERBERT's theory of knowledge is the discussion of Common Notions known by Natural Instinct. By way of Natural Instinct we receive the certainties, or Common Notions, of religion and morality. The Faculties whereby we learn the Common Notions are superior to the three other groups of Faculties : those of Internal Apprehension (feelings, emotions, conscience), those of External Apprehension (the senses), and those of Discursive Thought (logical inference). Such knowledge as commands

the universal consent of mankind " is the teaching of Natural Instinct and is essentially due to Divine Providence." (p. 117.) With such knowledge we are born, and such Notions are common not only to all men but in some important cases to men and other species as well. Thus in the highest degree common to all living creatures are " the law of selfpreservation and the desire for happiness." (p. 126.) In Natural Instinct the conformity of the Faculty with its object, the Common Notion, is " actually completed," and is not liable to error in the way that threatens lesser conformities. (p. 125.) The chief Common Notions conform with their appropriate Faculties of Natural Instinct without the aid of Discursive Reason. (p. 137.) We are reminded of SPINOZA's " third kind of knowledge " with its immediacy of apprehension. Indeed HERBERT's criteria of such knowledge are the following six : priority, independence, universality, certainty, necessity, and immediacy.

Common Notions " are found in all normal persons " and are " imprinted on the soul by the dictates of nature itself." (p. 106.) In short, here is a doctrine of innate ideas. " So the Common Notions must be deemed not so much the outcome of experience as principles without which we should have no experience. Let us have done with the theory that asserts that our mind is a clean sheet..." In a subsequent incarnation HERBERT is to live in Königsberg it seems !

(The Senses.) In a treatment of the internal and external senses HERBERT reveals most interesting influences of historical transition. It is here that the developing physiological research of his generation makes itself felt. HARVEY has, within the decade, published his researches into the circulation of the blood; and others are active in the survey of human and animal anatomy. The emerging scientific assurance in these regions expresses itself in HERBERT's insistence upon a sharpened line between the problems of conscience and morality and those of physical disease. " I would say, if the mass of worthy people will allow me, that it is more appropriate to attack physical disease by physical means. Those who insist that fearful distress and physical agonies can be alleviated, not to say banished, merely by the counsels of moral philosophy, display, in my opinion, somewhat meagre intelligence." (p. 180.) This commendably practical view finds its sanction in HERBERT's theory of the Analogy between the constitution of man and that of nature, a theory from which his whole thinking starts. And it might be noted that this trait of analogical reasoning is one of a number of scholastic habits which persist in HERBERT in spite of himself. " ... Our mind clearly corresponds to God and our body to the world, and the principles of all the differences in the world are inscribed in

man." (p. 169.) Much scientific quaintness remains, of course. " ... With black bile there goes peevishness..." (p. 179.) " ... The agitations of passion, anger, suspicion, envy..." " ... are analogous to that region in which hurricanes, whirlwinds, and meteors rage." (p. 171.) And in the midst of evidences of the modern temper there survive marks of the persisting tradition. In discussing the external senses HERBERT guards the epistemological realism of his position from the Franciscan nominalism of the descendants of OCKHAM. " I readily agree that there is nothing in the understanding which has not first existed in the sense..." (p. 209.) But any sceptical reflections upon our knowledge of substance will not do. " ... I maintain that we perceive substance essentially and colour accidentally, for it is a Common Notion that there is a substance or principle of inherence in things which may be absent." (p. 210.) Here, at a leap, we are in the milieu of medieval debate.

(Reason.) Discursive Thought is placed lowest in the order of reliable knowledge, and yet HERBERT has heralded his own " new " treatment of the categories—his " Zetetica "—with more than characteristic immodesty. One must confess that from the study of this " new method " of systematic thought one emerges disappointed and confused. The originality is specious. The attempt is solely of historical interest. The anti-Aristotelian tone is strident, and, in all likelihood, justified by the logical sterility of the latest Schoolmen. HERBERT's guiding ambition is the achievement of a method of reasoning which shall emancipate the religious (and Protestant) student from the authority of both priest and instructor. (pp. 281, 282.) But the method is no advance over the technique of the Aristotelian logic of classification. DESCARTES, not HERBERT, was the man of future significance in that generation, in that his analytical mathematics was a truly new method.

Nevertheless the evidences of transition in the Zetetica are important. The Scotist principle that each individual in nature has its individual essence as well as specific and generic essences is present here, albeit not in the pronounced form it is to have presently in LEIBNIZ' monadology.—The principle of the uniformity of nature is present in the form in which scholastic philosophy deeds it to us. " Nature never errs, and never sets before us a thing's characteristic feature apart from the thing itself, nor a thing without some characteristic feature." (p. 254.) The teleological identification of " essences " with " perfections " is no longer taken to be thoroughgoing, for the individual differences " generally indicate some defect or misfortune " rather than an " added perfection." (p. 255.) And finally, the importance of knowledge of the efficient causes in nature is recognized more fully. " ... The whole secret of

science consists in the discovery of means." "When we have found them the lawful Magic proclaimed by the ancients will emerge." (p. 271.)

"*The Father of Deism.*"—Throughout the theory of knowledge which HERBERT elaborates there is no doubt of its close connection with the theological beliefs of its author. It is directed in the first instance against the authoritarian theology of Catholicism, and in the second place is at pains to repudiate the rigid determinism and consequent predestination doctrines of the Calvinism then prevailing in the British Isles. A theory of knowledge which bids one look within to find certainty by the discovery of Common Notions is an instrument to hand for the private judgment of the Protestant. "Let everyone retire into himself and refer all the theories of the authorities to his own faculties." (p. 241.) All Revelation must submit to the test of the Common Notions. And since there is no Common Notion to the effect that the priests are to be obeyed unquestioningly, no Revelation which contains such an assertion can be true. On the basis of Common Notions the outlines of natural religion are traced. Five beliefs are universal in religion: namely—that there is a God, that he ought to be worshipped, that Virtue and Piety are the essence of religion, that Sin requires Repentance, and that after death there are Rewards and Punishments for the deeds of this life. Not universal in religion are rites, hierarchies, infant damnations, and other historical relativities. No sect has a corner on salvation. The tenet that any souls are cut off from God's grace and from "the means by which we can return to Him" as long as they are of good will is blasphemy. (p. 300.) The denial of freedom of will and the related assertion that we are inherently wicked are equally false. "No one is so subject to the compulsion of his nature as to be irresistably forced into evil." (p. 181.) "Rejoice in your freedom, that is to say, in your ability to be wicked, since because of this ability you are granted the opportunity of taking pleasure in good." (p. 205.)

Some trace of the English Franciscan tradition remains even so. "... There is no means which God in His great goodness may not employ..." (p. 312), wherefore the possibility of particular revelation is not to be denied outright. But since Revelation is handed down to us with no more than the authority of an historical event, it must in the first place submit to criteria of truth derived from the introspective ground of Common Notions (especially in the case of priestly Revelation). It must be received in prayer, and must be good in content and attended by the experience of the Divine Spirit. In the last analysis, neither the authority of reported Revelation, nor the authority of priests, nor the authority of Scripture is greater than that of our knowledge of the

Common Notions of Religion given by the Natural Instinct to every normal human being.

Mr. MEYRICK H. CARRÉ has prepared a most excellently readable translation of this text of early modern philosophy, and has prefaced it with an introduction of some sixty-six pages of cogent and precise analysis of the argument. The claim of the publishers that *De Veritate* is " the first important metaphysical work composed by an Englisman " may be set aside, by those who recall the rôle of Merton College in the thirteenth and forteenth century, as undue modesty.

(Williams College RICHARD HOCKING.
Williamstown, Mass.)

Amelia Defries.—*Sheep and turnips, being the life and times of* ARTHUR YOUNG, F.R.S., First Secretary to the Board of Agriculture. With a preface by R. A. BUTLER and an introduction by MONTAGUE FORDHAM. xx+235 p., portrait. London, METHUEN & Co. Ltd., 1938. Price 7/6 net.

Miss DEFRIES' life of this pioneer of scientific agriculture in Great Britain is a welcome addition to his autobiography which appreared in 1898. His *Tours of the Southern Counties* (1768), *North of England* (1770), *Ireland* (1780), *Kingdom of France* (1792), *Italie* (1796), and *Western Counties* (1809) are classic studies of rural life. His *Rural Oeconomy* (1770), *Experimental Agriculture* (1770), *Political Arithmetic* (1774), *Farmers' Calendar* (1805), and above all, the 43 volumes of the *Annals of Agriculture* (1784-1805) edited by him form a splendid collection of pioneer treatises in scientific agriculture. They were written during a period of very great economic, social, and political turmoil and of readjustments directly modifying agriculture, the movement of population, and the growth of industry, notably that in the weaving of woolen cloth. YOUNG was an influential proponent of the Enclosure Acts which made possible a higher grade of cultivation. He helped to introduce the culture of turnips and the provision of winter food for stock instead of the customary autumnal slaughter. His efforts greatly increased the agricultural resources of Britain and raised the standard of both rural and urban life. He conducted elaborate series of experiments on the effects of electricity on the growth of plants, on the relation of the air expelled by heat from soils to vegetation, and on the values and uses of fertilizers. He was also deeply interested in social and political questions concerning fixed values for agricultural products, labor and its compensation, and the detrimental effects of tithes upon agricultural holdings. Miss DEFRIES' book gives an excellent summary of his life,

travels, and contributions to agriculture and economics. There is a bibliography of works by and concerning him.

CHARLES A. KOFOID.

A. Wolf.—*A History of Science, Technology, and Philosophy in the Eighteenth Century*. 814 p. New York, MACMILLAN (History of Science Library), 1939. $8.00.

This volume forms the second instalment in WOLF's *History of Science* and as such is a companion piece to his volume on the sixteenth and seventeenth centuries (reviewed in *Isis*, vol. 24, p. 164, 1935). The 799 pages of text of the present work are divided as follows—mathematics 16 p.; mechanics 35 p.; physics 113 p.; astronomy and astronomical instruments 65 p.; chemistry 45 p.; meteorology and meteorological instruments 68 p.; geology 23 p.; geography 16 p.; botany 34 p.; zoology 18 p.; medicine 20 p.; technology 170 p.; psychology 27 p.; social sciences 51 p.; philosophy 53 p. Of course these divisions are purely arbitrary and it seems unfortunate that Prof. WOLF has chosen to divide his material into such strict categories. For example, the work of LAGRANGE is split up among three sections : mathematics, mechanics, and astronomy, so that it is difficult to get a decent view of LAGRANGE's achievement as a whole.

The most disproportionate amount of space is clearly that allotted to mathematics, a mere 16 pages. As a result, there is no mention made of any attempts to put the calculus on a sound basis, other than the attempts of the English mathematicians. Nor is there mention of the attempts to give meaning to imaginary quantities, nor of the Italian school of mathematics, nor of STIRLING, MONTUCLA, and a host of others. It is certainly to be regretted that CONDORCET is mentioned only as a collaborator in hydraulic experiments. If CONDORCET is not one of the most significant figures of the century, he is certainly one of the most interesting. As a leading figure in French thought and public affairs, in addition to having made valuable contributions in probability and theories of educational reform, he deserves more mention than this, if only in the light of his position as *secrétaire perpétuel* of the *Académie*.

The example of CONDORCET yields the clue to the composition of the volume, for however important he may have been to an eighteenth century viewpoint, he seems much less important to the twentieth. Thus, too, from the twentieth century point of view, physics is much more exciting than the other sciences, what with transmutation, atom-splitting, and relativity. This may help to explain why physics receives 113 pages while botany, zoology and medicine combined receive only 72 pages (about on a par with meteorology), a reflection of our

own interest, rather than that of the eighteenth century, surely (1).

The long section on technology (170 p.) is very welcome, especially as it is one of the best. The long sections on astronomical and meteorological instruments are equally welcome and form one of the most original features of the book. Not only are there good accounts of the new instruments, but there are also valuable details about the men who designed them and the technicians actually responsible for their execution. In many cases, these technicians themselves were responsible for new improvements. This aspect is usually neglected and it is, of course, particularly valuable in a study of the eighteenth century, with the so-called industrial revolution. For anyone interested in the relations of science to technology and of science to society, this part of Prof. WOLF's work will form a valuable and stimulating addition to the literature.

The book is very uneven, and Prof. WOLF's race with Time to write the history of all science in all countries in all times is, in a definite sense, a guarantee of shoddiness. Yet, the present work will serve a useful function. For there is no other work, in English at any rate, to which elementary students of the history of science, scientists and historians (who are not historians of science), can be referred for a picture of science in the eighteenth century. The book is generously and handsomely illustrated but the complete absence of source references tends to lessen the value of the pictures. There is a complete index and the excellent printing contributes to making this a very handsome volume indeed.

(*Carnegie Institution.*) I BERNARD COHEN.

Frederick P. Gay.—*The Open Mind* : ELMER ERNEST SOUTHARD, 1876-1920. Chicago : Normandie House, 1938. XXIII + 324 p.

Dr. ELMER ERNEST SOUTHARD, who died at the age of forty-four, in 1920, left a distinctive mark on American psychiatry. Coming from New England stock and educated at the Boston Latin School, Harvard College and the Harvard Medical School, SOUTHARD was a true product of Boston. He developed early and unusual qualities in his personality were already apparent in his early twenties. His study of the classics at the Boston Latin School brought him honors and provided him with a philological background, which he used to the greatest advantage in his later life. In college he continued his classical education, but philosophy and psychology, then flourishing at Harvard under PALMER, PEABODY,

(1) On this subject, see W. P. JONES, The vogue of natural history of England, 1750-1770, *Annals of science* 2, 345-352, 1937 or D. MORNET, *Les sciences de la nature en France*, au XVIII[e] siècle, Paris, 1911.

ROYCE, JAMES and MÜNSTERBERG, soon attracted him and he gained the highest honors in these studies. It is interesting to note, moreover, that interspersed with his scholastic attainments, chess became a major form of recreation. He soon became champion of the college and later a " master " chess-player and a winner of national tournaments. SOUTHARD is known to have played six, and even more, blindfold games at one time. Equipped, therefore, with a remarkable memory and well grounded in the classics as well as philosophy, he left Harvard to enter the Harvard Medical School.

There his attention was particularly directed towards pathology, especially the pathology of the nervous system. His accomplishments in this field finally carried him to the chair of neuropathology in the Harvard Medical School, a position which he held at the time of his death. Soon after leaving the Medical School, he entered actively into the field of psychiatry, bringing to bear upon the subject of mental diseases all his previous training. A service in pathology at one of the State hospitals in Massachusetts, with widespread research, marked him as a man of outstanding characteristics. In 1912 he was appointed the first director of the newly built Psychopathic Hospital in Boston. It was there, during the last eight years of his life, that his psychiatric work was accomplished.

In psychiatric thought SOUTHARD integrated all the facets of his many-sided personality. His philological training was revealed in his ingenious classification of mental diseases and his philosophical ideals colored his endeavors in psychiatric social service, of which he was virtually the modern founder. His prime achievement in psychiatry was his monograph on the " Kingdom of Evils," a masterly presentation of the influences which lead to mental aberrations : disease, ignorance, vice, resourcelessness and legal entanglements. From his study of patients at the Psychopathic Hospital he felt that these were the five principal sources which led patients into hospitals for mental disease. With the idea of simplifying the subject for the psychiatric social worker and for the doctors who had to care for these patients, he described these groups in terms of alleviation : morbi—cure; errores—teach; vitia—train; penuriae—provide; litigia—counsel. Thus he covered the whole kingdom of conflict in simplified language and in a manner different from that of any philosopher before him.

When SOUTHARD died suddenly at the age of forty-four, he had literally dozens of plans in mind for books, research and extension of his studies. It seems likely that a man so unusually equipped as he, and with a mental capacity which might well be classified as genius, would have accomplished work of vast importance in relation to mental diseases. He had only begun to lay down certain of the foundations and often these foundations

are in sketchy outline. It is from them, however, that Professor GAY has written a biography and, in the opinion of the reviewer, he has given a true picture of the man. SOUTHARD's importance, perhaps, lies not in what he actually accomplished, but in what he stimulated others to do, for there have already appeared in this country instances of projects which he began.

(Boston) HENRY R. VIETS.

Louis I. Dublin and **Alfred J. Lotka.** With the collaboration of the staff of the Statistical Bureau.—*Twenty-five years of health progress.* A study of the mortality experience among the industrial policyholders of the Metropolitan Life Insurance Company 1911 to 1935. XII + 611 p., numerous charts and tbls. in text. New York, Metropolitan Life Insurance Company, 1937.

As a document of historical importance in the history of the biological sciences and the art of medicine this record is of prime significance for several reasons. It covers a period, 1911-1935, of the practical applications of discoveries in bacteriology, serology, parasitology, preventive medicine, and pharmacology, tending to reduce and prevent the incidence of disease and its consequences. It includes a body of statistical data gathered under scientific control from a large and representative body of persons numbering 8,000,000 in 1911 and increased to 17,000,000 in 1935. Within this period the average duration of life has been extended 14 years. It includes the epochal World War, the most extensive epidemic recorded in human history, and a period of world-wide economic depression. Within this quarter of a century public health operations in milk pasteurization have reached an extent and efficiency resulting in a reduction of tuberculosis of bovine origin, rapid reduction of typhoid fever, and a marked decline in infant morbidity and mortality due to enteritis.

The use of diphtheria antitoxin has become so widespread and effective that in progressive cities a child's death due to this once dread disease is an anomaly. The most striking feature of mortality statistics is the decline in deaths from tuberculosis. In 1911 it was the leading cause of death among policy holders of this insurance company, whereas in 1935 it receded to the seventh place, declining from 242 in the initial year to 56 in the final one. There are those who fear that this record may be only a cyclic wave of change in virulence of the agent or of susceptibility of the victims and that enthusiasts over public health victories may later be disillusioned, but only the future can decide this.

While diseases of the young have yielded to control, those of middle life and old age have been more stubborn and these age classes have at the same time increased their proportions in the total population.

Diabetes and pernicious anemia have come under therapeutic control but many afflictions such as cancer and cardiac diseases still take their seemingly increasing toll in the face of remedial measures.

Surgery, with the aid of better methods of diagnosis and the use of X-ray, fluoroscope, and electrocardiograph and improved anesthetics, performs operations formerly impossible.

Human environment has been changing. Higher standards of living, especially among employed persons have become available due to education in matters of diet, wider availability of varied fruits and vegetables, better and more sanitary housing, shorter hours of labor, more recreation, more and better nursing services, and health education in home and school. Specific health hazards such as influenza-pneumonia have been studied with resulting improvements in typing the forms of the pneumonia bacillus and in the use of serums.

In the field of industrial hygiene great advances have been made in the elimination of hazards, the education in safety measures, and the discovery of unsuspected chemical dangers. The mixture of gin and gasoline by automobile drivers still takes an increasing toll. The control of this hazard is in the hands, to a large degree, of the police and auto insurance companies but not of their victims or those who insure them.

This report discusses the general mortality from all causes, the trend of longevity through the quarter of a century under review, the communicable diseases of childhood, tuberculosis, influenza and pneumonia, cancer, cardiovascular-renal diseases, diabetes, puerperal diseases, typhoid and other diseases of special interest, and the external causes of death. Throughout all the statistical records of these afflictions of mankind the influenza epidemic of 1917-1918 imprints its immediate and subsequent influences in figures and graphs.

This record of disease in relation to a changing human environment is impressive and significant in volume, scope, extent, and skillful analysis.

CHARLES A. KOFOID.

Jacob R. Marcus.—*The Jew in the Medieval World*, A Source Book, 315-1791. XXVI+504 p. The Union of American Hebrew Congregations, Cincinnati, 1938. (Price $3.00).

The history of the Jewish people is written in the letters of many alphabets and in many lands. But few readers ever get beyond the report of the events that happened to the primary or first-hand sources themselves. Most people find it much more pleasant and convenient to rely on the knowledge of other men than delve into the records themselves and let the actors and their contemporaries tell their own story. This may be the easier way of reading history, but not always

the safer, for much may happen not only to spoil the effect, but distort the very picture one wants to get. Impersonal history may be the dream of the philosophers, but so far as is known, has never been attained. The personality of the historian not only affects his style, but colors and influences the facts and events he narrates. At least in history, distance does not lend enchantment. It was one of SHELLEY's sayings, that every great historian is also a great poet, which is the reason why we have so much poetry and so little history in our text-books.

The impression has been created that sources make dull and uninteresting reading, intended for the professional scholar rather than for the lay reader. It is a popular prejudice, and those who had experience in the matter know that just the opposite is the fact. Because the digging up of primary sources involves a great deal of spade work and heavy research, it does not follow that the results must be dull and heavy. On the contrary, they often prove more vivid and striking than any touching-up can make them. When facts and events are allowed to speak for themselves, they speak with a tenfold force. What makes the biblical period of Israel's history so unforgettable an epic is the fact that the characters in that drama speak their own parts and tell their own story. It is a voice and not an echo that one hears, full of the power and passion of the events that created it.

There is no more moving chapter in Jewish history than that narrow, grim, gloomy and credulous period known as the Middle Ages. Unfortunately, for the Jews the Middle Ages lasted a much longer time than for the rest of the world, at least fifteen hundred years—from CONSTANTINE THE GREAT to the first democratic state of the French Revolution—if it can be said to have ended yet! If the first period created and fashioned the character and personality of the Jew, the second may be said to have disciplined him and made him proof against any emergency. It is the period which reached its epic climax of suffering in the Crusades, the Black Death, the Inquisition and expulsion from Spain, a time in which the Jew was a citizen nowhere and a chattel everywhere. With little variations, his status was the same in all lands, whether living under the shadow of the cross or the crescent, whether his oppressors were Christian kings or Moslem rulers. The Church exploited him for his religion, and the kings and emperors for his purse, but neither would allow him to be obliterated quite completely, for it was in their interests that he should be preserved.

And yet, in this grim, narrow and almost incredible life, the Jew was not a passive victim, but developed a world of his own which was not without its compensations. What the world would not give him, he took for himself. He expanded the walls of his ghetto till it included

almost every variety of intellectual and spiritual endeavor. Scientists, scholars, thinkers and poets were there, and saints and dreamers, too, who played the game of pseudo-Messiahs. Since the Jew had no standing in the world, he created a little world of his own, in many respects a unique and remarkable world, with a community organization able to enforce obedience without police, courts, jails or armies, and a universal language which was understood where Jews happened to live. It is this which makes the Jew in the medieval world so interesting and fascinating a character and, despite his suffering, the quaintest figure in the world.

Prof. MARCUS has rendered this part of Jewish history a distinct service by compiling, for the first time in the English language, a source book which makes the position of the Jew in the medieval world intelligible by letting the *dramatis personae* and their contemporaries speak for themselves without any attempt at editing or embellishing them. The material is abundant, covering at least a dozen languages and dialects with as many countries. It was a herculean task, requiring great industry, discriminating judgment, and a keen perception to distinguish between what is vital and what is trivial. That the author has acquitted himself well of his task and given us a source-book of the Jew in the Medieval World which has all the earmarks of a unified and connected story, readable throughout, is something for which both students and lay readers will be grateful to him.

In such a book, a pioneer work of its kind, one should not look for perfection. One should rather be thankful for what had been done and look for improvement and corrections to the second edition, of which the book is eminently deserving. It is, however, regrettable that the author should have ignored reference to Hebrew material in his suggested readings for advanced students. The writer has in mind S. BERNFELD's source-book for the persecutions of the Jews during the Middle Ages, *Ned Shel D'maot*, in three volumes, S. DUBNOW's great work on the history of Hasidism, S. A. HORODEZKY on the same subject, and DAVID KAHANA and BALABAN on the Shabbatian and Frankist sects. Other such omissions might easily be duplicated. It cannot be that these standard works escaped the author's attention, or is it because of his lack of faith in the advanced students' ability to follow a Hebrew text?

There are other omissions which are more deplorable, since thereby the reader is denied acquaintance with perhaps the most charming treatment of their respective subjects. The writer has reference to such books as ISRAEL ZANGWILL's " Dreamers of the Ghetto," " Jewish Mysticism," by J. ABELSON, and JOSEF KASTEIN's " History and Destiny

of the Jews;" the latter, although tendencious, nevertheless, makes admirable reading.

The reviewer was surprised to find that no mention was made by the author of URIEL DA COSTA, perhaps one of the most interesting and picturesque figures of the seventeenth century, a Marrano Jew who returned to the synagogue, which he afterwards defied, was thrice excommunicated for heresy, and in the end committed suicide. Not only has a considerable literature grown up about him in the Latin, Hebrew, German and English languages, but KARL GUTZKOW, a German dramatist of nearly a hundred years ago, devoted to him one of his most touching plays which enjoyed unusual vogue in the Germany of the pre-Hitler days. URIEL ACOSTA, or DA COSTA, himself left behind an autobiography, " An Example of a Human Life," which, written in 1640, when death by his own hand was staring in his face, was first discovered and published by PHILIP LIMBORCH in 1687, and translated into English by THOMAS WHISTON in 1740. Although short sketches of the life and times of URIEL ACOSTA appeared a good many years ago, the most definitive work on the subject was done by CARL GEBHARDT in his " Die Schriften des URIEL DA COSTA," Amsterdam, 1922. JOSEF KASTEIN's " URIEL DA COSTA," Berlin, 1932, is the most recent biography of the Amsterdam heretic-philosopher. That in view of the popularity of the subject and the interest it created Dr. MARCUS should have completely ignored it, is an omission greatly to be deplored.

For the division and organization of the book, it may be said that the material is divided into three main sections : the first section, dealing with the relation of the State to the Jew, reflecting the latter's civil and political status in the medieval world ; the second section, dealing with the influence of the Church upon the life of the Jew and his well-being; and the third section, which contains four subdivisions, treats of the life of the Jew in its various aspects, including, " Jewish Self-Government," " Jewish Sects, Mystics, and Messiahs," " Jewish Notables," and " The Inner Life of the Jew."

In conclusion it should be stated that every chapter is introduced by a brief, but comprehensive narrative, written with clarity and understanding, detailing the facts and situations with which the particular source-material is dealing. Dr. MARCUS has written a book which should find favor with many classes of readers, lay as well as expert.

New York. JACOB S. MINKIN.

Joseph Bidez et **Franz Cumont.**—*Les Mages Hellénises. Zoroastre, Ostanès et Hystaspe d'après la Tradition Grecque.* Tome I, Introduction, XII+297 pp. Tome II, Les Textes, 409 pp. Paris, Société d'Éditions " Les belles Lettres," 1938.

Although it is a commonplace to emphasize the cultural interchange between Greece and the Orient, many details of this process are still obscure. At what time, from whom, and to what extent the Greeks borrowed ideas is a question being but gradually answered in recent years. In this connection the present book represents a very important step. BIDEZ and CUMONT set themselves the task of collecting all the Greek and Latin material which dealt with ZOROASTER, the great reformer of Mazdaism, and his alleged pupils and successors, OSTANES and HYSTASPES.

The chief stimulus for this undertaking lay in the discrepancy between the Mazdian teachings as revealed in the sacred books of this religion and the ideas and works attributed to ZOROASTER and other Magi in ancient literature. This discrepancy BIDEZ and CUMONT explain by a distribution of the Magi all over the Persian empire. Separated from their original home and influenced by Babylonian ideas, they did not preserve the purity of ZOROASTER's teachings. They followed the practices of primitive Mazdaism, acquired the knowledge of Babylonian astrology, came into contact with Greek philosophy, and attributed their own complex teachings to ZOROASTER. These were the Magi whom the Greeks knew and their beliefs are reflected in the Greek and Latin texts. Thus this collection represents not only the ideas which the Greeks and Romans formed about ZOROASTER, OSTANES, and HYSTASPES, but the very beliefs and practices of the exiled Magi themselves.

The collection of these texts which forms the second volume has been performed with great thoroughness and accuracy. Where no reliable editions were available the authors have edited the material on the basis of manuscripts. Copious notes form a running commentary on more detailed questions. The general problems which these texts represent, as well as the results at which the authors arrived, are presented in the first volume which is intended as an introduction to the study of the material. The whole deserves high praise for its comprehensiveness and for the sound judgment displayed by the two authors.

Great care has been devoted to the indices. A general index at the end of the first volume and indices of the authors of the texts, the names in the texts, and principal Greek and Latin words at the end of Volume II help the reader to locate the passages in which he may be interested. It is a pity though that the modern bibliography has not been collected in a separate appendix. BIDEZ and CUMONT have an impressive knowledge of the current literature dealing with

the various aspects touched upon in their work. Since their bibliographic references are scattered all over the two volumes the student is deprived of the advantage of acquainting himself with the bibliography more quickly.

Two periods have to be distinguished in the Greek reports about the life of ZOROASTER. The Pre-Alexandrian period extends from XANTHOS the Lydian who wrote in the fifth century and who probably introduced the name of ZŌROASTRES into Greek literature (I, pp. 5-6), down to ARISTOTLE who mentioned the Magi in his lost treatise, "On Philosophy" (I, p. 15 ff.). During this period the Greeks were not acquainted with any writings attributed to ZOROASTER, nor was there any influence of Greek philosophy upon the Magi. This changed after the conquest by ALEXANDER. Various books of the alleged authorship of ZOROASTER were catalogued in the Alexandrian Library (I, p. 31). The Stoics and Pythagoreans also became interested in him (I, p. 32 ff.), PYTHAGORAS being believed to have traveled to the Orient and to have been a pupil of ZOROASTER. Whereas the better Greek sources see in ZOROASTER a pious man and moral philosopher distinguished from the Chaldean astrologers (I, p. 33), other sources reflecting Babylonian influence made ZOROASTER the inventor of these arts, who now sometimes appeared under different names, like ZARATOS, etc., even as a different personality (I, p. 37). But ZOROASTER was not only connected with Babylonian science and Greek philosophy—the Jews also connected him with their own traditions and he was even made a prophet of Christianity (I, p. 50).

The teachings of the exiled Magi were by no means uniform, as the Greeks themselves noticed (I, p. 58). Sometimes they reflect orthodox Mazdaism, whereas sometimes Ahriman appears as a negative but equally powerful god. This latter idea, and the cult of demons connected with it, probably is a remnant of primitive Mazdaism which caused the equivalence of Magi and magicians as early as the fifth century B.C. (I, pp. 60-62). Another theological doctrine, however, that of Zervanism, according to which infinite time stands at the beginning of all things, is of Babylonian origin, for it presupposes the discovery of constant celestial revolutions, and is, moreover, linked in the texts with astrological fatalism (I, pp. 63-65). Zervanism therefore must have been alive amongst the Magi living west of Iran, who were influenced by Chaldeans and had adopted astrological beliefs (I, p. 72). The picture of ZOROASTER as the alleged founder of such beliefs would explain the character of the works which in later antiquity went under his name (I, p. 73).

According to SUIDAS three works went under the name of ZOROASTER: *On Nature*, *On Precious Stones*, and an astrological work (cf. II, p. 140). These are of particular interest here because they connect ZOROASTER

with certain cosmological and scientific speculations. These pseudonymous writings seem all to go back to the Hellenistic period. The book *On Nature* was perhaps known to BOLOS OF MENDES (about 200 B.C.) already. It contained an account of ZOROASTER's descent into the underworld (I, pp. 112-114), some passages dealt with astrological views on conception and childbirth (I, p. 114), and an extensive part must have been devoted to a peculiar kind of medical botany. It was probably from here that the Zoroastrean synonyms of various medicinal plants found their way into Pseudo-DIOSCORIDES and Pseudo-APULEIUS, perhaps through the medium of PAMPHILUS OF ALEXANDRIA (I, p. 116), whereas PLINY's references were probably taken from BOLOS (I, pp. 115-117). Finally, the book must have contained astronomical and astrological predictions, fragments of which passed into the Geoponica.

In their attempt to reconstruct the Pseudo-Zoroastrean works the authors do not simply rely on a mere mentioning of his name. They also look for confirmation in the actual contents of the work. It is, for instance, a criterion for the oriental origin of the astrological parts that the Dog Star plays an important rôle, since it can be related to the significance of Sirius in real Mazdaism (I, p. 123 ff.). However, it seems to me that the authors are not always on safe ground in their attempt to assign the fragments or excerpts to definite works. If it is true that *On Nature* contained astrological views, I see no possibility of deciding accurately whether certain passages belonged to this rather than to the astrological work proper.

The references to ZOROASTER as the author of magic works are doubtful. It was OSTANES who to the ancients represented the arch-magician and necromancer (cf. I, pp. 173 and 180-186). According to PLINY he accompanied XERXES on his war and introduced magic into Greece. His name, above all, became attached to demonology, to the magic lore of plants, animals, and stones, and to alchemy.

Nothing definite, however, can be established about the works which went under OSTANES' name. He must have written a book similar to the *On Nature* by ZOROASTER, since he appears as an author amongst the plant synonyms in Pseudo-DIOSCORIDES and Pseudo-APULEIUS. Whereas, however, the names attributed to ZOROASTER are Greek, those referred to OSTANES are barbaric. Hence it can be concluded that ZOROASTER's book was composed in Greek, whereas that of OSTANES was merely a translation (I, pp. 190-191). OSTANES, just as ZOROASTER, owes much of his fame to BOLOS (I, p. 198) who combined him with DEMOCRITUS. How close a relation was supposed to have existed between DEMOCRITUS and OSTANES is shown by the fact that from the fourth century A.D. on an alchemical book was used which had the title *Demokritou Physika kai Mystika*. Here DEMOCRITUS was made the associate of OSTANES and the latter revealed to him the famous dictum :

" Nature delights in nature, nature conquers nature, nature dominates nature " (I, p. 199). Although this book is of comparatively recent date the chemical technique attributed to OSTANES seems to go back to older oriental practices (I, pp. 204-206).

There is no doubt that much of the astrological, medical, magic, and alchemistic contents of these fragments attributed to ZOROASTER and OSTANES really represent beliefs and practices of the Magi. This is particularly true of those parts where astrology and downright magic are involved. The explanation that here Babylonian influence and remnants of primitive Mazdaism can be observed is convincing.

It is also to be admitted that valuable observations could be intermingled with these " naive aberrations " (I, p. 149). When, however, the authors go as far as to say : " Souvenons-nous que cette physique enfantine de l'Orient a été l'origine de toute l'histoire naturelle de l'antiquité " (ibid.) the statement needs further qualification. As far as it refers to the knowledge of plants, metals, stones, etc., it is at least debatable whether oriental magic was the first to acquire such knowledge. And if it is meant to infer that all the natural history of antiquity developed from such magic lore, this statement is very doubtful indeed.

On the other hand, there are certain ideas of Greek origin which reappear in these pseudonymous works and of which it remains uncertain how far they were taken over by the Magi. On page 147 of vol. I the authors say concerning the Magi : " Mais à côté de cette magie proprement religieuse, qui opérait par des évocations de démons, les Maguséens en connaissaient une autre, plus scientifique, qui est proprement une physique dévoyée. Ils croyaient les trois règnes de la nature unis entre eux et à l'homme par des ' sympathies et des antipathies ' mystérieuses. Si l'on pénétrait le secret de ces forces occultes, si l'on savait en provoquer l'action, on pouvait obtenir des effets prodigieux." The passage from the Geoponica to which the authors refer as an example of such " sympathies and antipathies " is not convincing, and they themselves call it a " fragment douteux " (II, 193).

It seems to me that the theory of sympathy has to be more clearly distinguished from magic beliefs. The former is a philosophical idea which can be traced back in Greece at least as far as THEOPHRASTUS, perhaps even earlier (1). It does not presuppose a world governed by spirits and demons. It is true that under its influence the Greeks acquired a philosophical concept which allowed them to take all kinds of superstitious remedies, etc., seriously. But it is significant that most of the Greek physicians in doing so rejected magic beliefs (2). For them the " physica " which play such an important rôle in the literature of ZOROASTER and OSTANES were remedies whose miraculous effects were proved by experience alone. It is therefore quite natural that the Magi are credited with having " experienced " the miraculous properties of the galactitesstone (II, 304, 7) and there is no need in this passage to assume dependence upon DEMOCRITUS (cf. I, p. 193).

(1) Cf. KROLL, *Hermes*, 69, 1934, p. 232.

(2) These questions have been discussed in full by L. EDELSTEIN, " Greek Medicine in its Relation to Religion and Magic," *Bulletin of the Institute of the History of Medicine*, Vol. V, 1937, pp. 201-246.

Even very mysterious concepts of later times may partly go back to much older Greek ideas. Thus the authors relate the dictum of " Nature delights in nature," etc., which OSTANES was supposed to have revealed to DEMOCRITUS (cf. above), to Stoic pantheism (I, p. 244 ff.). But if part of the meaning really was that nature does things " non par la raison " (I, p. 245), a parallel can be found in the famous passage of the Hippocratic *Epidemics* V, 5, 1 (Littré V, 314) where a contemporary of DEMOCRITUS wrote : " Nature is the physician of disease. Nature discovers its means by itself and not by thinking : blinking, for example, and the services which the tongue renders, and other such things. Untutored and untaught, nature does that which is necessary."

Having limited ourselves to those aspects of the work which are more closely related to the history of science we are far from having exhausted its contents. Let it be said that the fragments as well as BIDEZ and CUMONT's conclusions touch upon an astounding variety of problems, political, religious, and philosophical, which concern the history of the Orient reflected in classical and even in Syriac and Arabic sources. It would be a weak compliment to the two distinguished authors to repeat that the book deserves praise. It deserves more, viz. to be studied by everybody interested in the cultural history of antiquity and the metamorphosis of ancient traditions and thoughts.

(*The Johns Hopkins University, Baltimore, Maryland.*) OWSEI TEMKIN.

Institut de France, Académie des sciences. *Notices et discours.* Tome premier, 1924-1936. 753 p., ports. Paris, GAUTHIER-VILLARS, 1937.

Nous saluons avec plaisir le premier volume de cette nouvelle collection de gros in-quartos illustrés où seront réunis les notices historiques et les discours prononcés en diverses circonstances par les délégués de l'Académie. Les notices (anciens " éloges ") étaient publiées jadis dans les recueils des *Mémoires*, mais les discours étaient imprimés à part, restaient éparpillés et tombaient rapidement dans l'oubli. Ici tous ces documents sont réunis dans l'ordre de leur première publication, car chacun fut publié à part comme jadis et distribué séparément. C'est ainsi que beaucoup d'entre eux ont déjà été signalés dans notre bibliographie critique, chacun à sa propre place.

La plupart de ces documents sont des biographies, quelques unes, les " notices ", assez développées et critiques, d'autres, discours de commémoration ou de funérailles, assez brèves. Toutes ces biographies se distinguent par leur clarté et leur bienveillance; les auteurs ne cachent point leur fierté quand ils parlent des découvertes de leurs compatriotes, mais c'est une fierté de bon aloi et généreuse qui ne se change pas en dénigrement ni haine des étrangers. Quel contraste avec les biographies

hystériques qui se publient dans d'autres pays; le plus beau modèle du genre hystérique c'est la biographie de PHILIPP LENARD par J. STARK (1936; *Isis* 26, 531). Il faut le lire pour le croire, et même après l'avoir lu, on ne peut s'empêcher de se frotter les yeux et de se demander si l'on n'a point rêvé.

Nous donnons ci-dessous la liste de toutes les notices biographiques, longues ou brèves, dans l'ordre alphabétique. De plus, il y a quelques autres notes se rapportant à des jubilés d'institutions, tels que le Muséum et le Bureau des poids et mesures. Les longues notices sont accompagnées de beaux portraits, et parfois, très rarement, de bibliographies.

1.	ANDOYER, HENRI.	Astronome	1862-1929
2.	BASSOT, LÉON.	Géogr. Astronome	1841-1917
3.	BAZY, PIERRE.	Médecin	1853-1934
4.	BERTIN, EMILE.	Ingénieur naval	1840-1924
5.	BORDA, CHARLES DE.	Physicien	1733-1799
6.	BOSSUT, CHARLES.	Mathématicien	1730-1814
7.	CARNOT, SADI.	Physicien	1796-1832
8.	CARTON DE WIART, HENRI.	Homme d'état	1869-
9.	CHAPTAL, JEAN.	Chimiste	1756-1832
10.	CHARCOT, JEAN.	Médecin	1825-1893
11.	CHARDONNET, Comte DU.	Inventeur	1839-1924
12.	COSTE, HIPPOLYTE.	Botaniste	1858-1924
13.	DARBOUX, GASTON.	Mathématicien	1842-1917
14.	DEHÉRAIN, PIERRE PAUL.	Botaniste	1830-1902
15.	DELAGE, YVES.	Biologue	1854-1920
16.	DEPÉRET, CHARLES.	Géologue	1854-1929
17.	DOUMERGUE, GASTON.	Homme d'état	1863-1937
18.	DUPUYTREN, GUILLAUME.	Médecin	1777-1835
19.	FABRE, JEAN HENRI.	Entomologiste	1823-1915
20.	FERRIÉ, GUSTAVE.	Physicien	1868-1932
21.	FLAHAULT, CHARLES.	Botaniste	1852-1935
22.	FRESNEL, AUGUSTIN.	Physicien	1788-1827
23.	GENTIL, LOUIS.	Géographe	1868-1925
24.	GOURSAT, ÉDOUARD.	Mathématicien	1858-1936
25.	GRIGNARD, VICTOR.	Chimiste	1871-1935
26.	GUIGNARD, LÉON.	Botaniste	1852-1928
27.	HALLER, ALBIN.	Chimiste	1849-1925
28.	HATON DE LA GOUPILLIÈRE, JULIEN.	Mécanicien	1833-1927
29.	HAUG, ÉMILE.	Géologue	1861-1927
30.	HUYGENS, CHRISTIAAN.	Physicien	1629-1695

31. Laplace, P. S.	Mathématicien	1749-1827
32. Laveran, Alphonse.	Médecin	1845-1922
33. Lecomte, Henri.	Botaniste	1856-1934
34. Lindet, Léon.	Chimiste agricole	1857-1929
35. Lister, Joseph.	Chirurgien	1827-1912
36. Lumière, Louis.	Inventeur	1864-
37. Maquenne, Léon.	Chimiste agricole	1853-1925
38. Mathieu, Louis.	Astronome	1783-1875
39. Matignon, Camille.	Chimiste	1867-1934
40. Maupas, Émile.	Protozoologiste	1842-1916
41. Mesnager, Augustin.	Mécanicien	1862-1933
42. Moissan, Henri.	Chimiste	1852-1907
43. Moureu, Charles.	Chimiste	1863-1929
44. Newton, Isaac.	Mathématicien	1642-1727
45. Niepce, Nicéphore.	Physicien	1765-1833
46. Painlevé, Paul.	Mathématicien	1863-1933
47. Pedro II d'Alcantara.	Associé étranger	1825-1877
48. Pinel, Philippe.	Médecin	1745-1826
49. Poincaré, Henri.	Mathématicien	1854-1912
50. Priestley, Joseph.	Chimiste	1733-1804
51. Rabut, Charles.	Ingénieur	1852-1925
52. Rateau, Auguste.	Ingénieur	1863-1930
53. Rey, Jean.	Ingénieur	1861-1935
54. Richet, Charles.	Physiologiste	1850-1935
55. Sebert, Hippolyte.	Mécanicien	1839-1930
56. Termier, Pierre.	Géologue	1859-1930
57. Viala, Pierre.	Phytopathologiste	1859-1936
58. Volta, Alessandro.	Physicien	1745-1827
59. Vulpian, Alfred.	Médecin	1826-1887
60. Witz, Aimé.	Ingénieur	1848-1926

Cette collection sera fort précieuse pour les historiens de la science. L'Académie a raison de publier ces biographies dans des volumes assez massifs qui ne s'égareront point, et d'éviter ainsi l'éparpillement et la destruction des hommages qu'elle a bien voulu rendre à la mémoire de savants illustres.

George Sarton.

Joseph Needham and **Walter Pagel** (Editors).—*Background to Modern Science*. XII+243 pag. New York : The MACMILLAN Co., At the Cambridge University Press, 1938 ($2.00).

This volume is made up of ten lectures on the history of science which were delivered at Cambridge in England in 1936. The lectures were arranged by the newly formed History of Science Committee of which Dr. JOSEPH NEEDHAM is chairman and Mr. WALTER PAGEL secretary. Since the lectures comprising this volume were delivered at least four additional series have been given. These courses of lectures have been extremely well attended, and the Cambridge Committee is to be congratulated upon a highly successful venture. It is greatly to be hoped that each series of lectures will receive speedy publication.

In their introduction to the volume the editors have some excellent things to say about the history of science and of the attitude towards it of certain kinds of scientists. Very properly they urge historians of science " to present the history of scientific thought always in relation to the social and economic background of the time." In conclusion the editors express the " hope that all these efforts will end by the general recognition of the history of science and technology, both in Cambridge and elsewhere, as the great cultural subject which it is," a hope in which we may heartily join.

The present series of ten lectures constitutes the inaugural course arranged by the Committee and covers the period from 1895 to 1935, the lectures being delivered by scientific workers who had themselves made fundamental contributions to science during that period. The result is a delightful, instructive, valuable, and important volume.

In the first lecture on Greek Natural Philosophy and Modern Science Professor F. M. CORNFORD succinctly states some of the essential differences in the attitudes towards science of the Greeks as compared with ourselves, and makes the very important point that in a community where the free labour supply was so great and so easy as it was in Greece it was quite unnecessary to enlist non-human force in industry. " There was thus no economic pressure driving men to study Nature as a source of mechanical power," and no necessity, therefore, to check such power or to inquire into its nature. This seems to me an extremely interesting and important observation. The remaining ten lectures are entitled as follows : From ARISTOTLE to GALILEO, by WILLIAM C. DAMPIER ; " Forty Years of Physics, by Lord RUTHERFORD ; Forty Years of Crystal Physics, by W. L. BRAGG ; Forty Years of Atomic Theory, by F. W. ASTON ; Forty Years of Astronomy, by ARTHUR EDDINGTON ; Forty Years of Physiology and Pathology, by JOHN A. RYLE ; Forty Years of Parasitology and Tropical Medicine, by G. H. F. NUTTALL ;

Forty Years of Evolution Theory, by R. O. PUNNETT; and Forty Years of Genetics in which, among many other interesting observations Professor J. B. S. HALDANE points out the very intimate connection between the development of systematic botany in the mid-nineteenth century and the economic exploitation of newly discovered countries. It is of some interest to observe here that from Professor NUTTALL's lecture it is quite clear that the development of modern tropical medicine was almost entirely determined by economic factors, and that it was the most imperialist of politicians who made the first school of tropical medicine possible! I await with impatience the publication of the other series of Cambridge history of science lectures.

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

David Lindsay Watson.—*Scientists are human.* With a foreword by JOHN DEWEY. xx+249 p. London, WATTS & Co., 1938. 7s. 6d. Microfilm copies of complete original manuscript, Document 1015, American Documentation Institute, 2101 Constitution Ave., Washington, D.C., $6.54.

Dr. WATSON has written the prologue to a book which has long needed writing. This volume, which is but a part of a considerably longer manuscript obtainable in microfilm form, deals with some of the relationships between the human personality, social organization and scientific development. The book stems from a diverse and varied intellectual parentage; a genealogy which includes JANET, BROUWER, KORZYBSKI, BRIDGMAN as well as THOREAU, EMERSON, LEWIS CARROLL and SPENGLER. The variegated points of view which are incorporated in this work can in part be understood as an attempt to integrate this heritage; to fuse the poet and scientist into a composite personality seeking truth and beauty and eschewing personal ambition, philistinism and routine drudgery.

Primary attention is devoted to factors which hamper, distort and vitiate the development of science. It is well to remember this; else, the catalogue of ills which, according to Dr. WATSON, beset the corpus of science will seem to presage the early demise of a youngster who is, in fact, surprisingly healthy. The author is clearly concerned with sources of *inadequacy* in the present organization of science, and his judgments should be examined within this context.

It is in this connection that he cites cases of lag in the general recognition of such important work as that of GIBBS, SOPHUS LIE, MAYER, CARNOT, WATERSON, and the best known of all, FOURIER's paper on the propagation

of heat. [The author's statement that NEWTON's *Principia* had to wait twenty years for " any adequate recognition " is either ambiguous or erroneous. The first edition was sold in short order. Can Dr. WATSON be referring to NEWTON's *own* delay in announcing the law of gravitation ?] He suggests that these instances of neglect partly derive from the social organization of science, involving bureaucratism, and from conceptual fixation, which leads to the rejection of radically new developments without fair consideration.

The varied details of this work defy brief summarization. Dr. WATSON's theses are partly contained in the following excerpt from his work : " The beliefs, customs, prejudices and institutions of the society all influence the science which it fosters. Science is relative to and therefore dependent on :

(*a*) The social forces which produce the scientific habits of mind.
(*b*) The social forces which encourage or oppose the scientist in undertaking his work,
(*c*) The institutions through which he has to work—universities, laboratories, scientific societies, journals, etc.,
(*d*) The operations by which the scientist learns to understand the relevant achievements of other men,
(*e*) The operations by which he submits his work to the judgment of others,
(*f*) The operations by which they collectively judge of its value, and
(*g*) The social forces which aid or hinder the proper appreciation of his work by later generations—when it is no longer new."

These theses are documented in considerable detail.

Partly through the irritant quality of his presentation as well as the " eccentricity " of his views. Dr. WATSON's book becomes literally stimulating. It is likely that no reader will agree with his position in full but it is equally probable that none will leave this work without an enhanced appreciation of problems involved in the organization of scientific activities.

R. K. M.

Lancelot Hogben.—*Science for the Citizen.* XIII+1082+XIX pp. New York : ALFRED KNOPF, 1938 ($ 5.00).

Before, while, and after reading this book I had the opportunity to peruse with much interest somewhat in the vicinity of a score of reviews of it. I do not, as a purely cautionary practice, place much faith in reviews, not even in my own, for a review is after all merely one man's

opinion of a book judged by such standards as he has managed to gather to his horizons. I have often found that even the most reliable of reviewers have upon occasion either completely belied the work which they have reviewed, done it scant justice, or judged it uncritically; that is, *in my opinion*. I speak not only of the reviews which appear in the better literary journals, but also of those which appear in first-rate scientific journals. I have before me at the moment of writing one such scientific journal in which the editor makes a practice of writing virtually *all* the reviews. Let it suffice to say here that from these reviews it is quite evident that he never reads the books upon which, from the vantage-point of a complete ignorance of their contents he pronounces judgment. But this is, perhaps, an extreme case. The reviews which I have seen of this latest popular work to come from HOGBEN's pen have unexceptionally been laudatory. The English reviews led me to expect that when at last a copy of *Science for the Citizen* did reach my hands it would really be a delightful experience. The American reviews were, interestingly enough, a little calmer, though still laudatory. At any rate, when eventually I did get to the book itself and had read the first few score of pages my disappointment was extreme. This feeling of disappointment was not greatly reduced by the time I had arrived at the last pages of this enormous work. What was the reason for my disappointment? Had I been led to expect too much? It is possible. Was the style wrong? No, the style is good. Too many errors of fact? No, there are relatively very few. Then what? Well, I know this: When I was a boy there was a work called *The Popular Educator*, it was issued in parts (once a month, I think), the complete work formed two volumes, and as I remember it it made much more interesting reading and certainly much easier reading than HOGBEN's latest volume, and it covered a great deal more ground. My feeling of disappointment is due to the fact that I do not find HOGBEN's book as good as my popular educator was. Undoubtedly HOGBEN's book is in many ways sounder and certainly more humanely balanced than my educator was. HOGBEN's emphasis on the historical and social aspects of the subjects with which he deals was absent from my educator, but if I had to choose between my old educator and HOGBEN I would unhesitatingly plumb for the earlier not-so-learned work because it was easier to read and to learn from. Surely, if we are to make science attractive to the citizen, (and it is, of course, open to question whether that is desirable), our first essential must be the realization that our citizen hasn't much time; that what science he is going to acquire in his spare time he will want to acquire as painlessly as possible. This he could have done with my old educator, but with HOGBEN's book he will have to take a stool

and apply the seat of his trousers to it very very hard, and concentrate, and furrow his brows, and work, and get a headache because he has tied himself all in knots, and the consequence will be that *Science for the Citizen* will look very nice on the bookshelf in its pretty jacket, while other things will suddenly occur to our citizen as of more urgent importance while the dust gently gathers upon the blue-black top of science. If this diagnosis is correct then the purpose for which HOGBEN wrote this book is defeated. It is devoutly to be hoped that my diagnosis is incorrect. Let me say only that I found HOGBEN's book very difficult reading in parts, that without intense application it would be impossible for me to follow many of his arguments and demonstrations, not in the least because they are badly put, but because their very nature is such as to demand real work on the part of the reader unprepared in the particular subject under discussion. I have already indicated that I object to hard work; this, of course, may be a personal idiosyncrasy. Perhaps another eccentricity of mine is a preference for acquiring knowledge in ways which I regard as pleasurable. I find that knowledge so acquired has a habit of remaining with me, whereas knowledge acquired by the sweat of my brow has a habit of evaporating very quickly. But this is perhaps a purely individual matter. I mention it here only as an explanation of my chief objection to HOGBEN's great book. Maybe it is not an objection at all.

Whatever one may think of the potentially educative effects which the book may exert upon the citizen there can be no two opinions concerning the remarkable achievement that this book represents, it is splendid. The author calls his book a handbook of scientific humanism. I am not sure that it is that, but to conclude this very grudging review I will say this: Anyone who gives this book the attention it deserves will be a great deal better for it.

The line drawings by HORRABIN are excellent, but the half-tones have been very poorly done, which is a great pity. The index is good, and there is a section containing answers to examples. It is a magnificent five dollar's worth, and one of the best examples of good popular science writing—for the educated reader—to have appeared for a long time.

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

W. H. Watson.—*On Understanding Physics.* XII+146 p. Cambridge, at the University Press; New York, The Macmillan Company, 1938. Price $2.25.

Contemporary physics has stimulated several divergent movements in philosophy of science. It has provided the spring board for leaps

into speculative metaphysics and religious philosophy on the part of EDDINGTON and JEANS. It has furnished examples for the operational theory of concepts expounded by BRIDGMAN. It has offered problems of analysis in the logical structure of language. The book under review contributes to the latter movement. The author has been associated with WITTGENSTEIN, whose oracular utterances in his *Tractatus Logico-Philosophicus* have intrigued logicians since RUSSELL introduced that work to the world about twenty years ago. WITTGENSTEIN is almost a legendary figure to philosophers, for only selected persons are said to be privileged to hear him lecture. In view of Professor WATSON's first hand knowledge of WITTGENSTEIN's logical theories, the present philosophical analysis of physics from the eminent logician's point of view is of great value.

Philosophy in the sense of WITTGENSTEIN is the activity of clarifying meaning. The problems of philosophy pertain to the logic of language. It is the business of physicists and other experimental scientists to use language to describe the world. Theoretical invention in physics consists in making new language for this purpose and in applying new language invented by mathematicians. The function of philosophy is to expound the logically grammatical use of language. Philosophical difficulties in physics arise from the logically ungrammatical use of notation. Understanding of physics is realized in knowledge of the proper use of the symbols which serve to represent nature.

The general results of the logical analysis of physics are exemplified by statements such as, " It should be clear that the laws of mechanics are the laws of our method of representing phenomena, and that since we actually choose a method of representation when we describe the world, it cannot be that the laws of our method say anything about the world " (p. 52). " The Uniformity of Nature is not a hypothesis about the world at all—we are not prepared to substitute an alternative hypothesis—it is a statement concerning our method of representing nature " (p. 56). " What we call causality does not correspond to a compulsion on nature to go in a certain way, but corresponds to the correct use of our symbolism " (p. 72). Concerning mechanism it is stated that it consists of logical connections of ideas and is the same as mechanism of calculation. " The permanence of substance is the continuing possibility of recognizing it : what remains the same is its name " (p. 95). Continuity or discontinuity is asserted to apply only to our method of representation. It is to be regretted that the author did not have the space available for more detailed analyses of the kind in the final chapter on some aspects of mechanics and the theory of electricity.

The author's description of physics as a symbolic representation of events demonstrates his competence in logical analysis and insight into some of the most abstract fields of theoretical physics. The reviewer believes, however, that the present book gives only a partial understanding of physics, on account of the author's almost exclusive attention to the symbolic aspect of physics. An adequate clarification of physics would require some reference to the history of physical concepts, analyses of experimental techniques, expositions of the conventions of measurement, and so forth. It is misleading to state with so little supporting analysis that the laws of mechanics state nothing about the physical world. As the reviewer has demonstrated (Experience and Convention in Physical Theory, *Erkenntnis*, VII, 4), fundamental principles play the role of definitions in physical theory, but they originate in generalizations from experience which exhibit the structure of the world and are transformed into postulates which constitute implicit definitions of the fundamental concepts.

The reviewer does not think that in the discussion of quantum mechanics adequate use is made of BOHR's explanation of complementarity in terms of mutually exclusive experimental arrangements. He approves, however, the transformation of DIRAC's statement that physical laws control a substratum, into one about the superstratum of our experience of actual things and processes, into the description of which the laws enter as part of the necessary symbolic apparatus.

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Berkeley, California.

V. F. LENZEN.

James Wilkinson Miller.—*The Structure of Aristotelian Logic.* 97 p. (Psyche monographs : no. 11). London, KEGAN PAUL, 1938 (10/6).

The author of this treatise maintains that " the principal issues in Aristotelian logic as it now exists are connected with the problem of *negative terms*." Accordingly, he has written a treatise which " aims to be a complete treatment of Aristotelian logic as containing negative terms." It is to be noted that since the interests of the book are not historical, there is no attempt to present the system of logic as set forth in the works of ARISTOTLE. The subject matter is the traditional logic and the expressions " Aristotelian logic " and " traditional logic " are used interchangeably.

The first four chapters present the traditional logic as a deductive system, no novelty in itself, as such postulational systems have already been given, notably by H. B. SMITH and E. A. SINGER, jr. But, as Dr. MILLER remarks, " The present set differs from theirs not only

in method and detail, but also in the fact that while negative terms are elements in the present system we do not introduce forms of propositions other than the *A*, *E*, *I*, and *O*." Chapters 5 and 6 are devoted to the rules for the syllogism (including rules for conversion as well as special rules for the sorites). Chapter 7 is devoted to interpretations of the formal system in terms of classes and to a collation and comparison of possible interpretations.

In the concluding chapter, after having stated the three aims achieved in his treatise (the presentation of traditional logic as a deductive system; the presentation of the rules of traditional logic in a form free from inconsistency and adequate to all forms of traditional argument; and the formulation of valid interpretations), Dr. MILLER takes up the important problem of the relation of traditional logic to modern (mathematical or relational) logic. Having established that negative terms can be completely and consistently treated in traditional logic, so that there is no need to reject them as " refractory elements," and having disposed of the " silly question " that is sometimes raised of the *correctness* of traditional logic, the author concludes :

> All the principles of traditional logic can be expressed in the language of modern logic; when so expressed they are principles of modern logic. Modern logic is of course a much more extensive system than traditional logic. Nothing in traditional logic corresponds to the modern logic of relations, nor to the modern logic of unanalysed propositions. Traditional logic is concerned simply with the logic of classes. But it does not treat even that branch of logic in its full generality. On the one hand it confines itself to a restricted conception of " class "... On the other hand, it does not deal with logical sums and products of classes. Traditional logic thus coincides with part of modern logic—but with part only. It is genuinely a part of Logic—but only a part. It is a special case.

One is led to wonder, then, just what is the value of traditional logic and, therefore, of a treatise such as the one at hand? For clearly logic has undergone tremendous growth toward generality in the development of modern logic (in the latter half of the nineteenth century and what has elapsed of the twentieth). About ARISTOTLE's *Organon*, the " backbone " of traditional logic, there have been in the past many controversial storms—mostly of a philosophical character but never really altering ARISTOTLE's original statement—reaching a sort of climax in the seventeenth century protests of FRANCIS BACON and JOHN LOCKE. As the first important alteration of logic itself dates from BOOLE, in evaluating traditional logic, it is well to recall the conclusion of the chapter on Aristotelian logic in BOOLE's treatise (1), the publication of

(1) GEORGE BOOLE : *An investigation of the Laws of Thought, on which are founded the Mathematical Theories of Logic and Probabilities*, London, 1854.

which marked the beginning of the new era. Although BOOLE did not live to see the " promised land " of the logic of unanalyzed propositions and general relations, he was able to state (p. 241) :

> To what final conclusions are we then led respecting the nature and extent of the scholastic logic? I think to the following : that it is not a science, but a collection of scientific truths... not sufficiently fundamental to serve as the foundation upon which a perfect system may rest. It does not, however, follow, that because the logic of the schools has been invested with attributes to which it has no just claim, it is therefore undeserving of regard. A system which has been associated with the very growth of language, which has left its stamp upon the greatest questions and the most famous demonstrations of philosophy, cannot be altogether unworthy of attention.

(*Carnegie Institution.*) I BERNARD COHEN.

Raymond Clare Archibald.—A semicentennial history of the *American Mathematical Society*, 1888-1938, with biographies and bibliographies of the past presidents. XI + 262 p., ports. Semicentennial addresses of the *American Mathematical Society*. 315 p. (*American Math. Soc. semicentennial publications*, in 2 vols.). New York, *American Mathematical Society*, 1938.

Although fifty years is not a very long time in the history of thought, it represents, for America at any rate, a considerable period in American mathematics. For we must remember that " mathematical research in America did not begin before the early part of the nineteenth century, when NATHANIEL BOWDITCH (1773-1838) and ROBERT ADRAIN (1773-1843) made a definite, though small beginning." By 1888, however, there had been an appreciable amount of research : there were such mathematicians as SIMON NEWCOMB, JOSIAH WILLARD GIBBS, BENJAMIN PEIRCE and others. By this time too, there had appeared ten volumes of the *American journal of mathematics* published by Johns Hopkins University and associated with the illustrious name of J. J. SYLVESTER, who was a professor there from 1876 to 1883.

When THOMAS S. FISKE returned in 1888 from England, he realized that the most valuable part of his European experience was to be found in the meetings of the *London Mathematical Society*. In his own words, " I was filled with the thought that there should be a stronger feeling of comradeship among those interested in mathematics, and I proposed to my classmates and friendly rivals, JACOBY and STABLER, that we should try to organize a local mathematical society." The society was duly formed and was known as the *New York Mathematical Society*. In 1894, the society changed its name to the *American Mathematical Society*, in token of its growing national character—which name it retains today.

It seems hardly necessary to trace here the rôle of the *American Mathematical Society*. That is sufficiently well known through its annual lectureships, its *Colloquium* publications, its journals, the *Bulletin* and the *Transactions*. Professor ARCHIBALD's account is, in any case, so complete and interesting that I refer all readers who are interested, to his history. In addition to its clarity, this history is so well written, and its organization so excellent, that should one wish to read just one detail, he can do so without having to read the preceding material. The first two chapters contain the story of the society. Following these, there is a chapter for each of the publications and one for each of the society's lectureships. There is also a valuable chapter concerning the library which is, of course, of especial interest to the historian of science; for this library (in the Low Memorial Library building of Columbia University) contains the precious DAVID EUGENE SMITH library and the DALE library of weights and measures, as well as the PLIMPTON library. A catalogue of the library was published in 1925 and a more complete catalogue was published in January of 1932 (126 p.). The last section of the book (p. 107-245) is devoted to the presidents of the society. For each one there is a portrait, curriculum vitae, a list of honors, biographical notes, and a complete bibliography of published writings.

The second semicentennial volume contains nine treatises, some of which are historical in nature and some designed to acquaint mathematicians with current problems and research in many fields. Under this second category are the following papers—J. F. RITT, *Algebraic aspects of the theory of differential equations;* R. L. WILDER, *The sphere in topology;* G.C. EVANS, *Dirichlet problems;* and J.L. SYNGE, *Hydrodynamical stability*. E. T. BELL contributes a paper, *Fifty years of algebra in America*, which he concludes with the following bit of advice— "...if there is anything that will give a man, young or old, a decent humility and a sane humor regarding his own efforts, it is an acquaintance with the work of his predecessors and contemporaries. The earlier this acquaintance is gained, the better for all concerned, including mathematics." It is for this reason that he advises the society to choose young men, preferably under thirty, to review the progress of American mathematics from 1938 to 1988 for the hundredth anniversary. Professor NORBERT WIENER's paper, *The historical background of harmonic analysis*, traces the main ideas of this part of mathematics from the principle of HUYGENS and the methods of LEIBNIZ through the FOURIER developments to the present time. Of course, Prof. WIENER is one of the leading figures in this field of research in our own time and so this account is of particular interest. I should like to call attention to that section (*circa* p. 61) which concerns itself with the nineteenth century, wherein Prof. WIENER remarks very

succinctly that it was " the real tragedy of the mathematics of the nineteenth century that, on the one hand, its physical stimulus was continually schematized, reduced in breadth, thrown into the background, or even forgotten, while on the other the experimental work of the physicists gradually sundered itself from the fertilizing influence of the development of mathematical theory." E. J. McSHANE's *Recent developments in the calculus of variations* is an attempt to sketch the achievements of the last twenty-five years in simple integral problems only; it has none of the completeness of Professor CARATHÉODORY's paper (*Osiris* III, p. 224-41). T. V. THOMAS' *Recent trends in geometry* is rather a schematized treatment of the " intrinsic theory of spaces that has been the center of attention in recent years due to the influence of EINSTEIN's theory of relativity."

The last paper, and the most interesting for the historian of science in general, is Professor G. D. BIRKHOFF's paper, *Fifty years of American mathematics*. Coming as it does from one of the most eminent mathematicians of our time, this paper is extremely valuable as prime material for the historian of science. Not that a leading mathematician is by any necessity a valuable historian of science,—but it is extremely useful to have an account of a period's general growth by one who has contributed so much to that growth. And besides, the account is extremely good, being at one and the same time an authoritative, as well as a highly personal, document. It is the aim of the society to show by means of this second volume " what has been accomplished in America since the founding of the society." Certainly this purpose is best realized in Prof. BIRKHOFF's paper. Reading these two volumes, one is tempted to echo sincerely Prof. BIRKHOFF's concluding remarks... " I have felt as a traveler in a beautiful and unexplored country might feel who had taken his companions to some vantage points familiar to him so that they might enjoy the prospects which he happened to know, all the while realizing that on the morrow they would journey together towards more grandiose mountain peaks glittering along the horizon."

(Carnegie Institution.) I BERNARD COHEN.

Tobias Dantzig.—*Number, the language of science.* A critical survey written for the cultured non-mathematician. Third edition, revised and augmented. x+320 p., 12 illus. New York, MACMILLAN, 1939 ($3.00).

The first edition of this book (1930) was fully reviewed in *Isis* (vol. 16, 455-59, 1931). The second edition (1933) was dealt with more briefly (vol. 20, 592). The third edition proves the success of this book, a

success on the whole well deserved. As far as the main text is concerned, it is essentially the same, and hence it would suffice to refer the reader to my first review. The principal change consists in the addition of 26 disparate appendices, some of which are very interesting.

My main criticism of the book, one that I failed to make previously, is the almost complete neglect of one of the most important extensions of the idea of number, that is, the extension of decimalization to fractions and measurements. The author has added in appendix 6 a note on the history of decimal fractions (p. 261-62), which aggravates that defect, for that is simply a brief account of decimal notations taken from CAJORI. This shows that he misses the point completely, for the changing notations are of little importance, while the discovery that submultiples of the unity could be written on the same basis as the multiples, and thus fractions assimilated to integers, was truly fundamental. Strangely enough that discovery was made by early Babylonians thousands of years ago but unfortunately applied to a sexagesimal basis. Later, the sexagesimal basis was abandoned but by a curious accident the sexagesimal fractions were continued (we are still burdened with them), and it was only in 1585 that a symmetrical treatment of multiples and submultiples was reestablished by SIMON STEVIN and the decimal numeration thus completed by him. The invention of logarithms helped the triumph of STEVIN's idea, yet it took two more centuries to extend it (as STEVIN had himself suggested) to physical measurements, and that extension is not yet universal. I have tried to tell that story in *Isis* (vol. 23, 153-244, 1935) but my account is too complicated and too technical, and it is a great pity that a master in simplification like DANTZIG did not introduce a clear outline of it in his own book. The more I think of it the more I am convinced that STEVIN's rediscovery of 1585 is one of the " milestones " in the history of number (it is not even mentioned in DANTZIG's table, p. 249) and that the development of the decimal idea, in spite of its technical simplicity, is one of the main lines of arithmetical progress.

GEORGE SARTON.

Augustin Sesmat.—*Le système absolu classique et les mouvements réels.* Étude historique et critique. 688 p., Paris, HERMANN, 1936, 100 frs. français. (Publié aussi en 7 fascicules des Actualités scientifiques et industrielles, Nos. 479, 480, 481, 482, 483, 484, 485).

Dès l'Avant-Propos, le lecteur est mis au courant des deux problèmes que l'auteur s'est proposé de résoudre : 1) y a-t-il un critère universel qui permette de discerner toujours les mouvements réels des mouvements corrélatifs qui ne sont qu'apparents et cela même dans le cas des astres ?

2) y a-t-il quelque *repère fixe universel*, quelque système de référence *absolu*, auquel tous les mouvements réels du monde puissent se rapporter, directement ou non ?

Écrivant surtout pour les non-spécialistes, M. A. SESMAT, professeur d'histoire et de critique des sciences à l'Institut catholique de Paris, s'est " toujours astreint à faire un exposé aussi élémentaire que possible mais suffisant de l'essentiel des doctrines ..." (p. 3). Aussi, l'homme de science, qui pourrait s'effrayer de la grosseur du volume, sera rassuré par le fait qu'il peut passer sans crainte une bonne moitié de l'ouvrage.

Signalons le bel exposé historique de l'Astronomie, des Grecs à NEWTON exclusivement. C'est dans les derniers articles (XXIV à XXVI, pp. 332-364) du Chapitre VI, après une étude détaillée de la Mécanique de NEWTON, que l'auteur expose sa thèse pour la première fois. Il rappelle que (p. 333) " pour déterminer complètement les mouvements des points et des systèmes de points dans notre construction abstraite, nous avons dû définir un système de référence ' absolu ' en ce sens qu'à son sujet la question du mouvement ou du repos ne pouvait pas et ne devait pas se poser. Ce système que nous avons appelé Σ nous apparaissait lié aux véritables positions initiales de repos des points matériels, c'est-à-dire à celles qu'ils étaient censés occuper avant qu'aucune force ait jamais agi sur eux..."

Hélas ! (p. 350) " dans notre science imparfaite, nous ne savons pas déterminer, ni le système absolu Σ, ni par suite le mouvement réel complet d'aucun corps "...

Les Chapitres VII et VIII sont consacrés aux théories de la lumière de FRESNEL, de MAXWELL et de LORENTZ. Quel sera le système absolu de l'Optique et de l'Électromagnétisme ? Après une longue analyse, A. SESMAT conclut notamment (p. 612) : " Sans doute nous n'avons plus aucun moyen de situer le système absolu relativement aux corps observables, mais d'abord nous avons toujours les mêmes raisons profondes d'affirmer son existence."

Nous ne pouvons suivre M. SESMAT dans ses conclusions. Les progrès de la science montrent de plus en plus le caractère inobservable du système de référence absolu Σ. Ne doit-on pas en tirer comme conséquence l'abandon du système absolu ? C'est une attitude possible, répond M. SESMAT, mais il en est une autre, l'attitude " classique " (p. 622-623). " Un premier caractère de la conception ' classique ' est son *réalisme :* nous entendons par là que les Physiciens classiques admettent volontiers l'existence réelle de données qu'ils savent inobservables directement, mais que l'induction leur permet d'affirmer, comme compléments nécessaires des réalités observables ou comme éléments d'une reconstruction intelligible du monde.

" Ce réalisme, qui sous un autre aspect est aussi un rationalisme, s'oppose à une sorte de positivisme négateur dont s'inspirent volontiers les théories nouvelles, et qui refuse de regarder comme réelle toute donnée inaccessible en droit à nos expériences directes."

Quoiqu'il en soit de nos critiques qui nécessiteraient une étude plus détaillée, nous sommes certain que cet ouvrage ne manquera pas d'intéresser le philosophe comme l'homme de science.

Bruxelles. JULES GÉHÉNIAU.

Augustin Sesmat.—*Les Systèmes privilégiés de la Physique relativiste.* Exposé méthodique et critique des théories d'Einstein. 449 p., Paris, HERMANN, 1936. (Publié aussi en 7 fascicules des Actualités scientifiques et industrielles).

Suivant la même méthode que dans le premier volume, l'auteur prend soin d'exposer les théories relativistes d'une façon suffisamment détaillée pour que le non-spécialiste puisse saisir l'essentiel de ces parties importantes de la Physique moderne. A ce titre l'ouvrage sera d'une grande utilité pour celui qui désire s'initier aux fondements de la Relativité.

Le premier Chapitre est consacré à la Relativité restreinte. Aussitôt après, (Ch. II, pp. 133-205), M. SESMAT aborde le problème de la recherche des systèmes privilégiés de la Relativité restreinte. Il conclut notamment, (p. 201) qu' " une théorie de l'histoire totale des phénomènes n'est possible que si l'on se réfère à un système d'inertie qui n'ayant jamais subi d'accélération est absolument privilégié en ce qui concerne la mesure du temps...", " S'il pouvait y avoir des corps liés à un tel système, leur temps serait le temps réel le plus long de tous ceux qui se sont écoulés depuis le début du monde ; en l'absence de corps absolument fixes depuis le commencement, un tel temps demeure idéal ; il n'en est pas moins concevable avec son privilège comme élément nécessaire d'une théorie complète du déroulement physique de l'Univers."

Au Chapitre III, (pp. 209-369), sont présentées les grandes lignes de la Relativité générale. Puis vient un exposé des " modes de repérages privilégiés de la théorie générale " (Ch. IV, pp. 373-396). Enfin, Ch. V, pp. 397-444), un essai critique sur les théories de la Relativité. Selon M. SESMAT, (p. 424), " même si la théorie relativiste est vraie, sa base philosophique et critique est fragile." Aussi, bien que (p. 425) " postulats philosophiques, réflexions critiques et principes formels [aient] joué un rôle de premier plan dans la construction de la théorie," " les relativistes, dans l'intérêt même de leur doctrine, feraient bien de ne pas encombrer de considérations étrangères à la Physique l'énoncé de leurs hypothèses, la déduction de leurs conséquences et la confrontation de ces conséquences avec les observations." Au surplus, (p. 443), " il est des exigences

fondamentales de la pensée que la philosophie se doit de respecter, de défendre au besoin, et à la lumière desquelles il est permis et même obligatoire d'examiner les postulats des théories physiques, surtout quand ils sont d'allure révolutionnaire."

Ces quelques brefs extraits suffiront peut-être à caractériser un aspect de l'attitude de M. SESMAT devant la Physique relativiste, attitude clairement exprimée dans les deux derniers Chapitres. L'esprit qui s'en dégage nous paraît peu favorable au progrès des connaissances humaines. L'histoire montre en effet que les idées, comme toutes les œuvres humaines, évoluent continuellement en liaison avec les autres manifestations de la vie. Aussi ne peut-il y avoir d' " exigences fondamentales...," à moins que celles-ci ne soient assez vagues et souples pour pouvoir s'accommoder de n'importe quoi ; mais alors, quelle est leur utilité scientifique ?

Bruxelles. JULES GÉHÉNIAU.

William Emerson Ritter.—*The California woodpecker and I.* A study in comparative zoology. In which are set forth numerous facts and reflections by one of us about both of us. XVI+340 p., colored frontispiece, portrait, 28 figs. Berkeley, University of California Press, 1938. Price $3.50.

It is a good deal of a shock to the conventional zoologist to pick up a book such as this whose challenging title suggests but does not fully reveal the fact that in it man is frankly recognized as an animal. He is actually treated as such and his structural make-up and behavioristic foibles are compared with those of a flying and feckless woodpecker.

Human anatomy, except at the hands of HUXLEY, GEGENBAUR, HOPF, ELLIOT SMITH, and a few others, has been developed by the acts of men whose interests in it are dominated by their allegiance to the medical profession. It has become highly technical, too often merely descriptive and without evolutionary or historical interpretation. The utter completeness of the intellectual detachment of the professional anatomist from enrichment by comparison is demonstrated by the fact that for many years the anatomists of America, at least, have withdrawn themselves from contamination by zoologists and have held their professional gatherings at other times and places with their medical confreres in the preclinical sciences. All too often human anatomy is an unknown field to the professional zoologist on his part. So the old myth of the distinct and unique position of man in the animal world resting upon philosophical and religious dogmas is continued to the mutual disadvantage of both of these administratively but not biologically separated scientific disciplines.

This book is an interpretative analysis of the organ systems and behavior patterns of a remarkably social bird with comparisons with those of the seemingly distantly related man with an occasional incursion up some philosophical alley, accompanied by keen analysis of their similarities and disparities.

The book bids fair to be of historical significance since it is the first whole-hearted attempt actually to utilize man in a comparative scientific study of a vertebrate below the level of the primates. Another reason for its historical significance is its revival of the natural history method of the study of a biological problem, a method characteristic of the work of CHARLES DARWIN.

CHARLES A. KOFOID.

William Bulloch.—*The History of Bacteriology.* XII + 422 p. London, New York, Oxford University Press, 1938 ($ 3.75).

Students of bacteriology and related disciplines have long been waiting for a history of their science. It has come at last. As Professor BULLOCH points out in his preface, " The collection of material for a history of bacteriology is a work of years and is not always easy or possible unless one has access to the largest libraries. Had it been easy it would not have been left so long undone."

The first history of bacteriology was written by the great LOEFFLER who planned a two-volume work but published only one part in 1887. The volume was soon out of print but this was no great tragedy for it had many errors. So students of bacteriology have had to wait fifty-one years for WILLIAM BULLOCH, Emeritus Professor of Bacteriology in the University of London to give them in his " History," the results of a lifetime of painstaking scholarship.

BULLOCH established himself as a historian of bacteriology with his article written for the first volume of the System of Bacteriology published in 1930 under the sponsorship of the British Medical Research Council. When in 1937 BULLOCH gave the Heath Clark Lectures at the University of London, he used his earlier paper as a basis and expanded his lectures into the present book.

In eleven chapters the author discusses such subjects as ancient doctrines of contagion, contagium animatum, spontaneous generation, fermentation, putrefaction and putrid intoxications, surgical sepsis, classification and cultivation of bacteria, PASTEUR's work on attenuation of virus, and ends with a short history of doctrines of immunity. Following the text is a splendid bibliography of sixty-three pages (this alone is worth the price of the book) and a fifty-eight page biographical dictionary listing no less than three hundred and thirty-one workers in and contri-

butors to bacteriology. The biographical index is one of the most remarkable features of this work and aside from certain omissions to be commented on later, I have been unable to find any obvious errors. Sixteen portrait plates and thirty-six illustrations illuminate the text, and subject and author indexes serve as keys to the contents.

The outline of the contents given above indicates at once that BULLOCH has written essentially a history of "medical" bacteriology. As such it is without question the most authoritative work on the subject. It is a pity that the title does not more accurately describe the text for it is as much a mistake to call this work a History of Bacteriology as it would be for an organic chemist to write a history of his speciality and call it a history of chemistry. The student of medical bacteriology may consult this work completely confident that he will find in it most of the material he needs to survey the historical development of his subject. But not so any one interested in agricultural bacteriology, soil microbiology or technical bacteriology. While it is true that the subdivisions of bacteriology stem from a common origin BULLOCH has focussed most of his attention on one limb of a many-branched tree.

As an example of the author's restricted viewpoint I mention the almost complete neglect of the social and economic aspects of the history of bacteriology. For instance, on page 45 we find a brief mention of the fact that one NICOLAS APPERT had invented a method for preserving food by means of heating it in hermetically sealed vessels. There is no mention of the fact that this invention came as a direct result of a plea by NAPOLEON who needed food for his soldiers and offered a prize of twelve thousand francs to the one who could solve the problem. Nor is there any discussion of the subsequent effect of APPERT's discovery on the progress of bacteriology, agriculture, the development of canning industries and even the success of colonial enterprise and commerce. JACOB HENLE receives full credit for his theoretical contributions to bacteriology but his contemporaries, the plant pathologists, receive no mention of the part they played in experimentally proving his postulates although in ignorance of his writings. The economic aspects of PASTEUR's work are but vaguely discussed and yet it is of the utmost significance that PASTEUR scarcely touched a problem that did not have a bearing on the economic life of his country.

But one must not quarrel too much after all with a difference in viewpoint. Each generation sees and writes its own history. In its sphere the book is excellent. BULLOCH's authority is grounded on the solid rock of the sources and it is difficult to single out portions of text for praise. The discussions on spontaneous generation, the specific element in disease and on the classification of bacteria are remarkable alike for

clarity and fairness of judgement. The style is not at all pedantic, being marked by simplicity, lucidity and at times brilliant flashes of wit. Errors are few and they are largely those of omission rather than of commission. It is surprising to note the slighting of ROBERT HOOKE who was the first to confirm LEEUWENHOEK's observations on the animalcules and not JOBLOT as BULLOCH tells us on page 29. Actually, ROBERT HOOKE demonstrated LEEUWENHOEK's "little animals" on November 15th, 1677 to a distinguished company which included Sir CHRISTOPHER WREN, Mr. HENSHAW, Dr. CREW, Sir JONAS MOORE and others. Also neglected is JOHN KING who in 1693 further confirmed LEEUWENHOEK and demonstrated by means of the animalcules the phenomena of plasmolysis, plasmoptysis and the bactericidal action of blood.

A most striking omission in view of its present-day importance is the subject of the filterable viruses. The name of THOMAS J. BURRILL, pioneer American plant pathologist and first to prove a bacterium as the cause of a plant disease is conspicuous by its absence as is also the name of HENRY SEWALL who first discovered the phenomenon of antitoxic immunity. And speaking of immunity as the author does for a whole chapter, one wonders why JENNER and smallpox vaccination were passed off with only a few sentences.

But enough. One cannot be a carping critic at the harvest which Professor BULLOCH has presented. It will be long before the work will have to be redone. Whoever provides us with a wider and more inclusive perspective of the history of bacteriology will do so from the vantage point of BULLOCH's shoulders.

It is a pleasure indeed to recommend this book. To the publishers we are indebted for a fine format and *mirabile dictu* a reasonable price. At $ 3.75 the book is a bargain.

Library of Congress. MORRIS C. LEIKIND.

George Herbert Mead (1863-1931).—*The philosophy of the act*. Edited, with introduction, by CHARLES W. MORRIS, *et al*. LXXIX+696 p. University of Chicago Press, 1938.

With the appearance of this volume, the fourth and presumably the last posthumous publication of his writings, MEAD takes his place beside PEIRCE and JAMES in the pantheon of American philosophy. Despite the sweeping range and diversity of subject-matter and the often fragmentary nature of the essays, the editors have in large part succeeded in integrating the materials. The pragmatic, organismic, empirical, teleological framework which MEAD consistently adopted provides the orientation for his analysis of knowledge and the act, his theory of perception, his cosmological and axiological formulations.

Professor MORRIS' lengthy introduction is by no means the least valuable part of this volume. The following passage quoted from the introduction is a useful, succinct summary of the contents :

> It is not difficult to see how the various branches of philosophy could be fitted into this [social] pattern of the act. Philosophy itself ' is concerned with import... of the presence in the universe of human reflective intelligence.' Logic becomes the analysis of the reflective act, deduction involving the confrontation of experience with an elaboration of existent meanings, induction involving the building-up of new meanings where old ones are not adequate; epistemology is transformed into an empirical study of the way knowing proceeds; the history of philosophy is interpreted—as is all history—in terms of the way thought extends memory for the guidance of the present; the philosophy of mind arises through a consideration of the manner in which the symbolical and the subjective arise as a stage in the reconstruction of the act; the philosophy of science is concerned with the genesis of scientific categories within the act and the relation of the world as presented by science to the world of common perception and the demands of action; metaphysics—when not used in the deprecatory sense of the artificial banishment of a problem by denying the reality of one member of the conflict and exalting the other—can be only the most general description of the world as it reveals itself in increasingly comprehensive social acts; axiology is grounded on a consideration of the consummatory or value phase of the act, the aesthetic being the penetration of consummation into early stages of the act, while the moral is the endeavor to achieve the maximum of value at the level of the social; education philosophically considered is seen as the process of internalizing the social act within the separate individuals and creating in them social interests; the philosophy of history is revealed as a consideration of the methods by which societies have sought to control themselves and their environments in the service of their basic needs and impulses; and the philosophy of religion is transformed into an empirical investigation of the nature of religious objects and the function they perform in the value system of society. [X-XI]

It is unlikely that any reader of *Isis* will fail to find some part of MEAD's discussion evocative of new perspectives and deeper insights. For other books of his, *The Philosophy of the present* (Chicago, 1932), see *Isis* 20, 307-10, and *Mind, self and society* (Chicago, 1934), see *Isis* 24, 189-91.

R. K. M.

Paul Shorey.—*Platonism Ancient and Modern.* Sather Classical Lectures XIV, University of California Press, Berkeley, California, 1938; 259 pp., $2.50.

The high honor of the Sather Professorship of Classical Literature in the University of California was in 1928-29 conferred for the third time on the distinguished Hellenist and Platonist, PAUL SHOREY, who delivered a series of eight lectures on the history of Platonism. At the time of SHOREY's death in 1934 the manuscript of these lectures

was unfinished, but the portions that were ready were seen through the press by his former assistant, Dr. PROCOPE S. COSTAS.

There are seven lectures dealing respectively with Antiquity, Neo-Platonism, Christianity, the Middle Ages, the Renaissance, French Literature and English Literature. The treatment is particular rather than general, and compressed rather than brief. It has been said that all the ideologies known to man, with many of their ramifications, are found expressed in jest or in earnest somewhere in the works of PLATO. A particular survey of Platonic influences, reminiscences and parallels in the world's philosophy and literature is therefore a huge enterprise. But SHOREY undertook it in his notebooks and has attempted to reduce this vast erudition into the compass of a moderate volume. Every page fairly bristles with names, many of them little known and hastily mentioned; and there are constant references to suppressed material.

The volume contains the fruit of a lifetime of reading on his chief subject of interest by a great scholar, one well known for his independence of opinion, merciless scrutiny of pretense and superficiality, penetrating thought and keen wit. In spite of its compression these qualities have not failed it and we are not disappointed. There is a wealth of observation, apt quotation and anecdote to relieve the densest thicket of facts. He points out p. 6 that "Aristotelians as a class only half understand their author," because almost every sentence in ARISTOTLE alludes to something in PLATO. Denouncing Epicurean science as being insincere (p. 17) he remarks: "The magnificent poem of LUCRETIUS, which even HUXLEY and TYNDALL and OSLER consider as the truest expression of the spirit and poetry of science, is disfigured by an ignorance of astronomy which a well-trained schoolboy in Athens or Rome, though not, I fear, in Chicago or Oxford, could have corrected." Poor CICERO, much berated these days by positivistic thinkers, wins SHOREY's praise (pp. 17 f., 33 f.) as the "best example of the transmission of Platonic thought by great Platonists." He ventures an important opinion on PLATO and Christianity (p. 85), "I think that today an increasing number of educated Catholics are beginning to perceive that in spite of the ingenuity of THOMAS AQUINAS' harmony of Aristotelianism and systematic theology, PLATO is, in the situation that now confronts the Church, a more helpful ally of essential religion than ARISTOTLE."

PLATO's influence on European civilization has been largely through translations. The early Middle Ages were restricted to CHALCIDIUS' version of the first half of the Timaeus, which was widely read. The publication in 1482 of FICINO's complete translation with introductory essays on each dialogue "was one of the greatest events in European literary history. For three centuries it was to all educated Europe

what JOWETT's *Plato* has been to England and America for the past forty years (p. 121)." From SHOREY's references *passim* it appears that FICINO's introductions usurped a great deal of attention that should have gone to PLATO himself. Few great writers have studied the text itself of PLATO. SHOREY signalizes RACINE and LA FONTAINE, COLERIDGE and SHELLEY. He enjoys pointing out indirect and false knowledge of PLATO, as in FONTENELLE, MONTESQUIEU, VOLTAIRE, Sir THOMAS MORE, BURTON, POPE.

The chapters on French and English literature pass in useful review the chief authors who bear any significant relation to PLATO. In the discussion of SPENCER and SHAKESPEARE (pp. 178-182), SHOREY would have been interested in a translation of the *Axiochus* by SPENCER, recently discovered and edited by F. M. PADELFORD for the Johns Hopkins University Press, 1934.

All Platonists will be grateful to the Editors for salvaging, though unfinished, this last work of a great Platonist.

Indiana University. AUBREY DILLER.

Harry Elmer Barnes and **Howard Becker.**—*Social Thought from Lore to Science.* Volume I, A History and Interpretation of Man's Ideas about Life with His Fellows. XXIV+790+LXXXIV pp. Volume II, Sociological Trends Throughout the World, VIII+791-1178+LXXVII. Boston : D. C. HEATH & Co., 1938, I ($5.00), II ($4.50).

These two volumes represent the most exhaustive and thorough history of social thought and survey of sociological thought throughout the world to be found in any language. The authors deserve the thanks of all enlightened students of mankind for their really superb achievement. The two volumes throughout breathe the spirit of that broad humanity which cultivates while it teaches, and in addition to this gratifying feature of the work the tremendous amount of theoretical and factual material which the authors present is handled so skilfully and easily that the work reads like what it is, the adventure of man's ideas about himself and life with his fellows.

The material of these volumes is so arranged that each work represents a self-contained entity, with its own apparatus of exhaustive notes and references and suggestions for further reading, and name and subject indices. In the first volume social thought from the earliest non-literate societies to the present day is discussed. I say " discussed " because although the work has the character of a text-book, it is much more than that, the authors *do* discuss and interpret the facts and the theories

which they have to present, and it is this part of their work which renders these volumes particularly valuable, for they are always well informed, sound and reliable. The second volume is a sort of *vade mecum* to the social thought and the sociology of what may be termed the modern period, from the latter part of the nineteenth century to the present day. It is admirable. It would be impossible to recommend or to praise these two volumes too highly.

Hahnemann Medical College and Hospital, Philadelphia. M. F. ASHLEY-MONTAGU.

George F. Black.—List of works in the New York Public Library relating to witchcraft in the United States (*Bulletin, New York Public Library* 12, 658-75, Nov. 1908).

—List of works relating to witchcraft in Europe (*Bulletin, New York Public Library*, 15, 727-55, Dec. 1911).

—A calendar of cases of witchcraft in Scotland, 1510-1727 (*New York Public Library*, 102, p., 1938).

The first two items are out of print, the third can be bought from the New York Public Library for 75 cents.

This review is primarily devoted to the last named item; the two earlier ones are mentioned to show that the author's activities in the field of witchcraft bibliography extend over thirty years and these activities are not by any means ended, for he is busy even now completing a " History of witchcraft in Scotland " the appearance of which is eagerly expected by his friends (1). Books on witchcraft have unfortunately obtained within recent years a new timeliness because the mass-psychoses caused by the fear of witchcraft are now reappearing under a new pretext in Germany and Italy and we are now witnessing in those countries exhibitions of collective inhumanity and criminality which recall to our minds the worst days of early persecutions. In those days the pretext was witchcraft and religious heterodoxy and it was held by " good " people as well as by bad ones that it was wrong to keep faith with witches or with heretics. (2) Today the pretext is if anything worse and the consequences seem more inhuman because of the very progress of science, of humanity and enlightenment in other countries.

The witchcraft disease appeared relatively late in Scotland. Except for a few isolated cases and in spite of growing credulity, the disease

(1) He is also completing a book on " The surnames of Scotland, their origin, meaning and history,"—but that is another story.

(2) See for instance GREGORY ZILBOORG : *The medical man and the witch during the Renaissance* (Baltimore, 1935; *Isis* 25, 147-52).

was not properly established until June 1563 when the Scottish parliament passed a statute against witchcraft. That statute acted exactly in the same manner as the papal bull of 1484; it created (or magnified enormously) the very evils which it was meant to destroy. BLACK gives a brief outline of the history of witchcraft in Scotland (p. 9-20), but the substance of his work is a very elaborate calendar of cases beginning in 1510 and extending to 1727. Each case is summarized and references to the sources *ad hoc* enable the reader to investigate it. This is followed by a glossary and full indices of names and places. In short, we owe the author a most valuable instrument for the study of a melancholic aspect of human frailty in earlier times. The reading of it is heartbreaking because we cannot help thinking of similar crimes, suicides and countless other tragedies caused today by a new kind of insanity and malice. As the Arabs say : " God protect men from the wickedness of men."

GEORGE SARTON.

Jan Nat.—*De studie van de oostersche talen in Nederland in de* 18e *en de* 19e *eeuw* (The study of oriental languages in the Netherlands in the eighteenth and nineteenth centuries). Amsterdam doctoral thesis. 188 p., port. Purmerend, J. MUUSSES, 1929 (in Dutch).

The history of orientalism is a fascinating subject which has not yet been covered with any completeness on any scale, and would deserve to occupy a man's life. If I had not already devoted mine to the history of science, I would like to tackle that new task. There are plenty of materials which would enable any orientalist, sufficiently well trained in various oriental languages, to make a good start without too much difficulty. He might begin with the outline of GUSTAVE DUGAT : *Histoire des orientalistes de l'Europe* (2 vols., Paris, 1868-1870), and continue with the *Essais orientaux* of JAMES DARMESTETER (Paris, 1883), and the *Vingt-sept ans d'histoire des études orientales, Rapports faits à la Société asiatique de* 1840 *à* 1867, by JULES MOHL (2 vols., Paris, 1879-80). More materials could easily be obtained in the jubilee volumes of various oriental schools and societies, in the *Festschriften* dedicated to famous orientalists, etc. With regard to special disciplines valuable information would be gathered from special books. For example, there is a list of Arabists in GIUSEPPE GABRIELI : *Manuale di bibliografia musulmana* (Roma, 1916; *Isis* 5, 449-50); there is a list of Christian Hebraists by RICHARD GOTTHEIL in the *Jewish encyclopedia* (vol. 6, 300-04, 1904); Sir E. A. WALLIS BUDGE has described *The rise and progress of Assyriology* London, 1925; *Isis* 9, 547); R. N. SARDESAI has published recently a collection of portraits of 103 western Indologists (Poona, 1938; *Isis* 31, 216).

I have analyzed recently in *Isis*, father ARDUINUS KLEINHANS' *Historia studii linguae arabicae...* (Rome, 1930; *Isis* 29, 189-91). That review had the advantage of drawing the attention of the illustrious Russian Arabist, Prof. IGN. KRATCHKOVSKY of Leningrad (*Isis* 28, 572) who kindly wrote me a long Arabic letter on the subject including valuable errata and addenda.

To begin with, JUYNBOLL's study on the seventeenth century Dutch Arabists (*Isis* 24, 220) was an Utrecht thesis published in 1931 (not 1934). The author, juffrouw WILHELMINA MARIA CORNELIA JUYNBOLL, is the daughter of the great Arabic and Islamic scholar THEODOR WILHELM JUYNBOLL of Utrecht. Moreover my Russian colleague pointed out to me the existence of an earlier Dutch thesis by JAN NAT (1929), centered upon the great Leiden Hebraist ALBERT SCHULTENS (1686-1750), founder of the comparative grammar of Semitic languages, grandfather of the Arabist HENRIK ALBERT SCHULTENS (1749-1793). Between them these two scholars span the whole of the eighteenth century. Some seventy pages are devoted to the elder SCHULTENS and his school; then the author deals with the other Dutch orientalists of the eighteenth century. A final chapter on the orientalists of the nineteenth century is divided into two parts, Semitic scholars (34 p.) and other orientalists (20 p.). The division is natural enough. We are given only a sketch, but a sketch which is apparently well documented and will be useful to later historians.

According to Prof. KRATCHKOVSKY, another sketch of Arabic studies in Europe was written in Arabic by the Austrian orientalist JOSEPH GYRA (52 p., many illustrations, Cairo, 1929). The book, entitled *Ta'rîkh dirâsat al-lughat al-'arabîyat bi Urûba*, is out of print but I have finally managed to obtain a copy of it from my bookseller in Cairo. It is curious but superficial and disappointing and of little, if any, value to the historian of orientalism.

GEORGE SARTON.

[Secondary Education].—*Report of the consultative committee on secondary education with special reference to grammar schools and technical high schools.* XXXVIII+477 p. London, Board of Education, printed & published by His Majesty's Stationery Office, 1938 (3 s. 6d.).

This is the first time, I believe, that a government report is reviewed in *Isis*, but the reader will soon realize that there are good reasons for making an exception in this case. The report is often called the SPENS report (e.g., *Nature*, Jan. 21, 1939, p. 103-06) after the name of the Chairman, Sir WILL SPENS, master of Corpus Christi College in Cambridge. Dr. ROBERT FITZGIBBON YOUNG, the very efficient Secretary,

not only edited the whole but contributed historical sections of great value, to wit, a " Sketch of the development of the traditional curriculum in secondary schools of different types in England and Wales " (p. 1-86), and the appendix II " on the development of the conception of general liberal education " (p. 403-14). These are learned contributions largely based on sources and which deserve to be rescued from the oblivion to which the majority of administrative documents are doomed.

At a time when the education of youth is founded upon hatred and superstitious ideas in some " civilized " countries, and when deliberate attempts are made in those countries to create mass-psychoses comparable in their stupidity and wickedness to the witchcraft delusions of former times, (1) it is refreshing to witness in England the development of a very different spirit, a spirit of generosity and toleration. Consider these statements apropos of " education for citizenship " (p. XXXVIII) :

" What is most important is inculcating a habit of mind. This may be done by emphasising the serious character of the social and other problems which have to be faced, and at the same time by insisting that, while there is need for enthusiasm in causes which are felt to be vital, there is need also for study and judgment, so that not only the reality of political differences but the measure of common ground may be fully recognised." ... " Further, History is not the only subject which can be made the vehicle of teaching which is valuable for this purpose. It does not follow that, because people have learnt to apply logical processes in mathematics, they will think logically about politics, nor that, because they have learnt to verify facts, and to try to check theories by facts, in the physical sciences, they will realise automatically the desirability of this procedure in other fields. On the other hand such ' transfers ' can be made at the least far more probable if in teaching, say, mathematics a real effort is made to bring out the significance of logical argument and to emphasise the desirability of such argument whenever possible, and if in teaching science the scientific method is expounded as a method which ought to be employed in other fields. By such means we can do something to counteract the excessive influence of emotional interests and inhibitions in the consideration of matters with which men are deeply concerned. It is obvious that education for citizenship along these lines depends at every point on conscious effort by teachers to use their opportunities. Success will, however, inevitably depend even more on the unconscious influence of example than on the most skilful use of opportunities. It is not possible to exaggerate the debt in this connexion which may be owed to a teacher by boys and girls who in their last years at school have come under the influence of someone who is able to combine with clear political opinions both wide sympathies and the habit of dispassionate criticism of political creeds."

Dr. YOUNG's Sketch is very interesting and though it naturally sets

(1) GREGORY ZILBOORG : *The medical man and the witch during the Renaissance* (Baltimore, 1935; *Isis* 25, 147-52).

forth many facts with which every historian of science is familiar it drew my attention to others which were new to me, e.g., the mathematical schools established in England in the latter part of the seventeenth century and the beginning of the eighteenth to satisfy the growing needs of the mercantile marine. Dr. YOUNG's summary of the increasing claims of science (p. 39-41) is very instructive. These claims were voiced in 1837 by WILLIAM WHEWELL, the master of Trinity and the author of one of the earliest histories of science, and were supported in 1851 by the Prince Consort; in 1854 by T. H. HUXLEY, JOHN TYNDALL and MICHAEL FARADAY; later by HERBERT SPENCER, FREDERICK WILLIAM FARRAR (then assistant master at Harrow), HENRY SEDGWICK, canon J. M. WILSON (at that time science master at Rugby). Surely a fine tradition!

Apart from some sections concerned with details of school administration, much in this masterly report transcends its immediate needs and will be read with profit by every humanist, especially by the "new humanists." I quote two examples:

"There is, however, still need to bring home to teachers the importance of biology as a fundamental element in any course of science teaching judged to be suitable for a rural school: not only because of its practical application to the problems of plant and animal life, but also because a knowledge of biology creates a fresh consciousness and appreciation of the manifold interests which life in the country has to offer, and a new attitude of mind towards the agricultural industry." (p. 195).

"It is often maintained that the study of the Bible should have a place in the curriculum for its literary value alone. We do not wish to underestimate that value. The English Bible is one of the glories of the literary heritage bequeathed to the English-speaking peoples. For that reason there is much to be said in favour of the inclusion of portions of the Bible in the syllabus of English literature. But it is also true that no boy or girl can be counted as properly educated unless he or she has been made aware of the fact of the existence of a religious interpretation of life. The traditional form which that interpretation has taken in this country is Christian, and the principal justification for giving a place in the curriculum to the study of the Scriptures is that the Bible is the classic book of Christianity and forms the basis of the structure of Christian faith and worship. The content of the Bible has, therefore, inevitably its own dignity and associations. It can neither be treated merely as a part of English literature, nor can it be merged in the general study of history, though its meaning is, in the first instance at least, historically conditioned" (p. 208).

The pages explaining how Latin ought to be taught are excellent, and I wish every Latin teacher would read them and take them to heart. Indeed, the outstanding scandal of secondary education almost everywhere is that so many boys and girls are obliged to spend years studying Latin, yet are taught it so badly that they never know it.

GEORGE SARTON.

Fifty-eighth Critical Bibliography

of the

History and Philosophy of Science and of the History of Civilization

(*to October* 1939—*with special reference to cent.* VIII *to* XIV *inclusive*)

The fifty-eighth bibliography contains about 780 items of which 229 deal with the VIIIth to XIVth centuries after Christ. They have been kindly contributed by the thirteen following scholars belonging to four different countries :

C. W. ADAMS (Hertford, England)
M. F. ASHLEY-MONTAGU (Philadel.)
I B. COHEN (Cambridge, Mass.)
T. L. DAVIS (Cambridge, Mass.)
C. A. KOFOID (Berkeley, Calif.)
C. D. LEAKE (San Francisco, Calif.)
R. K. MERTON (New Orleans, La.)
D. NORMAN (Cambridge, Mass.)
J. PELSENEER (Brussels)
A. POGO (Cambridge, Mass.)
G. SARTON (Cambridge, Mass.)
E. ZINNER (Bamberg, Germany)
C. ZIRKLE (Philadelphia).

This bibliography includes as usual a series of addenda and errata to SARTON's *Introduction to the History of Science*, vols. I and II (Baltimore and London, 1927 and 1931). Its purpose and methods have been explained in the preface to the 38th Critical Bibliography (*Isis* 20, 506-08).

The sections relative to the VIIIth to XIVth centuries after Christ are especially full, as I have liquidated as much as I could of my stock of notes concerning them.

I have in my drawers a large number of notes which I will be glad to publish as soon as I have been able to check them upon the originals.

The Historical and racial classification (Part II) contains a new section, (IV) " The New World and Africa " divided into three subsections (*a*) America, (*b*) Oceania, (*c*) Africa. (These subsections have not been numbered in order not to disturb the numbering of sections of Part III).

I entreat the authors of relevant books and papers to send me copies of them *as promptly as possible* in order that their studies may be registered in this bibliography and eventually reviewed and discussed. By so doing they will not simply help me and every other historian of science but they will help themselves in the best manner, for they will obtain for their

work the most valuable publicity and its certain incorporation into the literature of the subject.

Most of the notes were selected by me. They were typed by Miss FRANCESS SIEGEL and the typing read by I BERNARD COHEN. The proofs were read by Dr. A. POGO.

Harvard Library, 185 GEORGE SARTON.
Cambridge, Mass. October 31, 1939.

PART I

FUNDAMENTAL CLASSIFICATION (CENTURIAL)

VIth Century B.C.

Keyser, Cassius Jackson. PYTHAGORAS. *Scripta mathematica* 6, 17-22, 1 pl., 1939. ISIS

Vth Century B.C.

Cornford, Francis Macdonald. PLATO and PARMENIDES. PARMENIDES' *Way of truth* and PLATO'*s Parmenides*, trans. with an introduction and a running commentary. XVII+251 p. (International library of psychology, philosophy and scientific method). New York, HARCOURT, BRACE, 1939. ($3.75). ISIS

"About the significance of the second and longer part of PLATO's 'Parmenides,' scholars, in both ancient and modern times, have differed more widely than about any other of his dialogues. This book was undertaken in the hope that a study of the whole chain of argument would bring to light some method of interpretation that would give the dialogue a significance worthy of its author and consistent with its position in the history of Greek thought. The conclusion reached is that the second part of the dialogue is an extremely subtle and masterly analysis, dealing with problems of the sort we call logical, which were known to have been much on PLATO's mind in his later period. After a detailed introduction, which attempts to reconstruct the earliest Pythagorean cosmogony, Professor CORNFORD proceeds to an account of PARMENIDES's 'Way of truth' and of its relation to the rest of the poems, thence to a consideration of ZENO and his opponents."

König, Friedrich Wilhelm. Relief und Inschrift des Koenigs DAREIOS I am Felsen von Bagistan. XII+97 p., 2 pl., 1 map. Leiden, BRILL, 1938. ISIS

Marcy, G. A propos du périple d'HANNON (au sujet des conditions de la navigation antique). *Hespéris* 23, 67-68, 1936. ISIS

Nestle, Wilhelm. Hippocratica. *Hermes* 73, 1-38, 1938. ISIS

Nittis, Savas. The Hippocratic oath in reference to lithotomy. A new interpretation with historical notes on castration. *Bulletin of the history of medicine* 7, 719-28, 1939. ISIS

Pohlenz, Max. HIPPOKRATES. *Die Antike* 15, 1-18, 1939. ISIS

Souques, A. La douleur dans les livres hippocratiques. I. Diagnostics rétrospectifs. II. Affections de l'appareil respiratoire. III. Affections du tube digestif et du péritoine. *Bulletin de la Société française d'histoire de la médecine* 32, 178-86, 222-42, 1938; 33, 37-48, 131-44, 1939. ISIS

IVth Century B.C. (whole and first half)

Diepgen, Paul. Ein grosser Arzt und eine grosse Zeit in der Geschichte der griechischen Medizin. *Deutsche medizinische Wochenschrift* Nr. 8, 12 p., 1939. ISIS

Faddegon, Barend. Studies on PĀṆINI's Grammar. 72 p. (Verhandeling der Koninklijke Akademie van Wetenschappen te Amsterdam, Afdeeling Letterkunde, 38). Amsterdam, 1936. ISIS

IVth Century B.C. (second half)

Walzer, R. Fragmenta graeca in litteris arabicis, I. PALLADIOS and ARISTOTLE. *Journal of the Royal Asiatic Society*, 407-22, 1939. ISIS

IIIrd Century B.C. (whole and first half)

Euclide. L'Optique et la Catoptrique. Œuvres traduites pour la première fois du grec en français, avec une introduction et des notes, par PAUL VER EECKE. XLVII+126 p. Paris, DESCLÉE DE BROUWER, 1938. ISIS

Reviewed by AUBREY DILLER, *Isis* 30, 520-21, 1939.

Jaeger, Werner. Vergessene Fragmente des Peripatetikers DIOKLES VON KARYSTOS. Nebst zwei Anhängen zur Chronologie der dogmatischen Ärzteschule. 46 p. (Abh. d. Preuss. Akad. d. Wiss. Phil.-Hist. Kl., 3, 1938). Berlin, Verlag der Akademie der Wissenschaften, 1938. ISIS

JAEGER shows that DIOCLES was born a little before 340, reached his climax about 300 and was still flourishing in the *Peripatos* in the sixties of the third century. Hence my tentative dating of him in my *Introduction* (I, 121) —I put him in PLATO's time—was too early. G. S.

IIIrd Century B.C. (second half)

Bodde, Derk. China's first unifier : a study of the *Ch'in* dynasty as seen in the life of LI SSU, 280?-208 B.C. VIII+270 p. (Sinica Leidensia). Leiden, BRILL, 1938. ISIS

Sibirani, F. Il trattato delle spirali di ARCHIMEDE. *Bollettino di Unione matematica italiana* 1, 160-72, 5 fig., 259-74, 8 fig., 1939. ISIS

Ist Century (second half)

Wethered, H. N. The mind of the ancient world. A consideration of PLINY's *Natural history*. XVI+302 p., frontispiece. New York, LONGMANS, GREEN, 1937. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 521-23, 1939.

IInd Century (whole and first half)

Diller, Aubrey. Lists of provinces in PTOLEMY's *Geography*. *Classical philology* 34, 228-38, 1939. ISIS

Kubitschek, W. (1858-1936). Die sogenannte B-Redaction der ptolemäischen Geographie. *Klio* 28, 108-32, 1935. ISIS

Reviewed by L. BAGROW, *Imago Mundi* 3, 109, 1939.

Rome, A. Le problème de l'équation du temps chez PTOLÉMÉE. *Annales de la Société scientifique de Bruxelles* 54, 211-24, 1939. ISIS

" La définition actuelle du jour solaire moyen et du jour solaire vrai coïncide avec celle de l'*Almageste*. Le problème de l'équation du temps, chez PTOLÉMÉE, consiste à réduire en jours moyens un laps de temps donné en jours vrais. Pratiquement, dans l'*Almageste*, ces laps de temps commencent tous au 26 février - 746 à midi vrai d'Alexandrie; dans les *Tables faciles*, au 12 novembre - 323 à la même heure. Cette particularité permet, dans les *Tables faciles*, d'établir une colonne de corrections qu'il suffit d'ajouter au laps de temps donné pour le réduire en jours moyens. Chez ALBATTANI, il est probable que la colonne de corrections qui doivent toujours être soustraites, a la même signification que celle des *Tables faciles*. Le renversement du signe serait dû à ce que les laps de temps considérés en pratique commencent au 1er mars - 311. En passant, l'on recueille un renseignement sur l'astronome SÉRAPION."

Schnabel, Paul. Text und Karten des PTOLEMÄUS. VIII+128 p. 8 pl. (Quellen u. Forschgn. z. Gesch. d. Geographie u. Völkerkunde, 2). Leipzig, KOEHLER, 1938. ISIS

Vth Century (whole and first half)

Brett, G. Byzantine water-mill. *Antiquity* 13, 354-56, 1 pl., 1939. ISIS

Keenan, Sister Mary Emily. ST. AUGUSTINE and biological science. *Osiris* 7, 588-608, 1939. ISIS

VIth Century (whole and first half)

Diller, Aubrey. The tradition of STEPHANUS BYZANTIUS. *Transactions of the American Philological Association* 69, 333-48, 1939. ISIS

VIIIth Century (whole and first half)

Ayscough, Florence. TU FU, the autobiography of a Chinese poet, A.D. 712-770. Including an historical year record, a biographical index, and a topographical note as well as maps, plans, and illustrations. Arranged from his poems and translated. 2 vols. London, J. CAPE, 1929-34. ISIS

Bede (*Introd.*, vol. 1, 510-11). I should have insisted that it was BEDE who really introduced our Christian chronology. My attention was drawn to that by R. W. CHAMBERS' excellent lecture on BEDE (British Academy 1936, reprinted in *Man's unconquerable mind*, London, 1939, p. 23-52). ISIS

Says he (p. 49) : " In the sixth century a certain Scythian monk at Rome, known as DIONYSIUS EXIGUUS, in compiling his Easter Tables, had reckoned from the Incarnation. The exact measure of BEDE's originality here we shall never know : but BEDE was certainly the first scholar and historian to make the reckoning by the year of our Lord the standard reckoning. Every time we date a letter we should render homage to the Venerable BEDE."
G. S.

Chamberlain, Basil Hall. Translation of " *Ko-ji-ki* " or " Records of ancient matters." 2nd ed. with annotations by the late W. G. ASTON. LXXXVI+498 p., 1 map. Kobe, THOMPSON, 1932. ISIS

Inostrantsev, K. The emigration of the Parsis to India and the Musulman world in the middle of the VIII century. Translated from the Russian by L. BOGDANOV. Journal, Cama Oriental Institute, no. 1, 33-70, 1922. ISIS

Jones, Charles W. Bedae pseudepigrapha : scientific writings falsely attributed to BEDE. XV+154 p. Ithaca, N. Y., Cornell University Press, 1939 ($3.00). ISIS

Four works bearing BEDE's name are certainly authentic, the *De temporibus* (703), *De natura rerum* (c. 703), and the much larger *De temporum ratione* (725), including BEDE's chronicle of the history of the world, finally the *Epistola ad Wicthedam*, discussing the date of the vernal equinox. Our readers will remember the author's study of 56 Mss. of *De natura rerum* (*Isis* 27, 430-40, 1937.) The present volume is a precious contribution to our knowledge of BEDE, and of the writings rightly or wrongly ascribed to him. The texts discussed were all included in vol. 90 and 94 of the *Patrologia latina* the purpose of which "was to err on the side of inclusiveness." Prof. JONES recognizes 9 items as genuine (the 4 above-mentioned plus 5 others) and discusses 46 other items " dubia et spuria." Says he : " This work is a prelude to an edition of BEDE's computistical writings. Such an edition would be premature as long as his true work is obscured by a body of spurious writing attracted to his name. Though it has long been recognized that BEDE never wrote many of the works discussed in this volume, students have continued to cite the spurious works under his name or as ' pseudo-BEDE.' Consequently, competent scholars have often confused the material with BEDE himself and more often have regarded these spurious writings as English thought of BEDE's time when they may well have been written, let us say, in Germany in the eleventh century. Conversely, here and there in this drab set of writings is a passage that has been neglected in its setting and deserves attention as the serious creation of a worthy mediaeval writer, even though his name has been lost to us. If I have succeeded in clearing away some of the repeated misinformation of the past few centuries by reference to known manuscripts and early printed editions, my purpose will have been achieved. This book has no more unity than *Patrologia Latina*, Tom. XC, on which it is based. My method is first to explain how this body of writing became attracted to BEDE's name and then to discuss each separate work as it appears in that volume, showing (insofar as I am able) the period and district in which the work was written."

G. S.

Pierson, J. L., jr. The *Manyôsû*, translated and annotated. Book III. XIX+379+2 p. Leyden, BRILL, 1933. ISIS

Thompson, A. Hamilton (editor). BEDE, his life, times, and writings : essays in commemoration of the twelfth centenary of his death. With an introduction by the Bishop of Durham. XVI+277 p. New York, Oxford University Press, 1935. ISIS

VIIIth Century (second half)

Guidi, Michelangelo. La lotta tra l'islâm e il manicheismo. Un libro di IBN AL-MUQAFFA' contro il *Corano* confutato da AL-QÂSIM B. IBRÂHÎM. Testo arabo pubblicato con introduzione, versione italiana e note. XXVIII+128+56 p. Roma, R. Accademia Nazionale dei Lincei, 1927. ISIS

Lehmann, Paul. Das literarische Bild KARLS DES GROSSEN, vornehmlich im lateinischen Schrifttum des Mittelalters. 72 p. (Sitzungsberichte der Bayerischen Akademie der Wissenschaften, phil.-hist. Abteilung 1934, 9). München, BECK, 1934. ISIS

(Takakusu, J.) Le voyage de KANSHIN en Orient (742-754). Par AOMI-NO MABITO GENKAI (779). Traduit par J. TAKAKUSU. *Bulletin de l'École française d'Extrême-Orient*, 28, 1-41, Hanoi, 1929. ISIS

KANSHIN was the founder of the Buddhist sect *Ritsu* (one of the " Six sects of Nara "); see my *Introduction* (vol. 1, 510). TAKAKUSU's translation was made into English, and then retranslated into French! G. S.

Toussaint, Gustave-Charles. Le dict de PADMA, *Padma thang yig*, Ms. de LITHANG traduit du thibétain. 540 p. (Bibliothèque de l'Institut des hautes études chinoises, 3). Paris, LEROUX, 1933. ISIS

IXth Century (whole and first half)

Datta, B. On MAHÂVÎRA's solution of rational triangles and quadrilaterals. *Bull. Calcutta Math. Soc.*, 20, 267-94, 1928-29. ISIS

Drexl, F. Studien zum Text des ACHMET. *Byzantinische Zeitschrift* 33, 13-31, 271-92, 1933. ISIS

See my *Introduction* 1, 558. G. S.

Jessup, Everett Colgate. RABANUS MAURUS : *De sermonum proprietate, seu de universo*. *Annals of medical history* 6, 35-41, 1934. ISIS

Leclerc, Henri. Le petit jardin *(hortulus)* de WALAHFRID STRABUS, abbé du monastère de Reichenau. 108 p. Paris, LEGRAND, 1933. ISIS

Paret, Rudi. AN-NAẒẒÂM als Experimentator. *Der Islam* 25, 228-33, 1939. ISIS

Smith, Margaret. An early mystic of Baghdad. A study of the life and teaching of ḤÂRITH B. ASAD AL-MUḤÂSIBÎ. A.D. 781-A.D. 857. XI+311 p. London, Sheldon Press, 1935. ISIS

IXth Century (second half)

Antuña, Melchor M. Manuscritos árabes de " al-Ḥâwî " de AL-RÂZÎ en la Biblioteca de El Escorial. 20 p. (Extracto de la *Revista Medicina*, 6). Madrid, 1935. ISIS

Elgood, C. A Persian manuscript attributed to RHAZES. *Journal of the Royal Asiatic Society*, 905-09, 1932. ISIS

Apropos of a brief text entitled *Barri' ul-sâ'at* (Cure within the hour) ascribed to AL-RÂZÎ. The Ms. is modern (1266 H.). Short analysis of it. G. S.

al-Jâḥiẓ, Abû 'Uthmân 'Amr ibn Baḥr. *Kitâb ad-dala' il wal i 'tibâr 'alâ l-khalq wa-t-tadbîr*. Edited by MUḤAMMAD RÂGHIB AṬ-ṬABBÂKH. 80 p. Ḥalab, 1346 (1928). ISIS

Kletler, Paul. JOHANNES ERIUGENA. Eine Untersuchung über die Entstehung der mittelalterlichen Geistigkeit. 63 p. (*Beiträge z. Kulturgesch. d. Mittelalt. u. d. Renaissance*. Hrsg. v. W. GOETZ. Bd. 49). Leipzig, TEUBNER, 1931. ISIS

Ruska, Julius. Pseudepigraphe RASIS-Schriften. *Osiris* 7, 31-94, 1939. ISIS

Xth Century (whole and first half)

Beichert, Eugen. Die Wissenschaft der Musik bei AL-FÂRÂBÎ. Ein Beitrag zur mittelalterlichen Musiktheorie. 48 p. (*Kirchenmusik. Jahrbuch*, 1932). Regensburg, PUSTET, 1932. ISIS

Bergdolt, Ernst. Beiträge zur Geschichte der Botanik im Orient. 1. IBN WAHHSCHIJA : Die Kultur des Veilchens (Viola odorata L.) und die Bedingungen des Blühens in der Ruhezeit. *Ber. d. Dt. Bot. Ges.*, 50, 321-36, 1932. ISIS

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which an artist derives from arranging his symbolism and imagery. The ninety-nine poems or songs of which the *Wu chên p'ien* consists are masterpieces of Chinese literary craftsmanship. All or certain ones of them, particularly those near the end of the Essay, were probably intented to be sung or chanted."

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This edition has been prepared with great care and is offered in the best manner, with all the necessary paraphernalia : critical notes, glossary, study of the MSS, determination of the date (c. 1230), etc. It augurs well for the new series of the Anglo-Norman Text Society, of which four other items are already announced. Members of that Society pay 20 s. a year and receive its publications in return for their subscriptions. G. S.

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" The purpose of this paper is to sum up the voluminous research which has been done on *Piers Plowman* in the past thirty-five years in order to make easily accessible the important results of that research and to point the way towards future developments." ... " The immediate future in *Piers Plowman* scholarship seems to me to be in two directions, omitting for the moment the textual work which is basic and apt to extend over many years; (1) the study of the meaning of LANGLAND's words and lines, and (2) a general study of the backgrounds in folklore, art, theology, homilies, religious tractates, and various literatures, as well as in social and economic history."

Devlin, Mary Aquinas. Bishop THOMAS BRUNTON and his sermons. *Speculum* 14, 324-44, 1939. ISIS

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Ellinwood, Leonard. The works of FRANCESCO LANDINI. XLIII+ 316 p., frontispiece. (*Studies and documents*, 3). Cambridge, Mass., Mediaeval Academy of America, 1939 ($3.00). ISIS

" With this edition of the works of FRANCESCO LANDINI it is hoped that the composer may cease to be the mythological figure he has appeared in the past. By making FRANCESCO's works available to the student in a collated transcription of the manuscript sources, it is my further hope to replace previous speculations regarding many aspects of fourteenth-century music with the music itself, without distortion, in an edition from which deductions may be drawn with a greater degree of accuracy than has hitherto been achieved. This work has been made possible by the splendid coöperation of the European libraries in the furnishing of complete photostatic copies of all manuscripts concerned, by the excellent services of the Sibley Musical Library, Eastman School of Music, University of Rochester, in securing the materials of the Bibliography, and by the courtesy of the Cornell University Library, which provided the materials on *trecento* Italian literature from its distinguished collection." FRANCESCO LANDINO was born in Fiesole 1325 and died in 1397. He became blind in childhood because of smallpox. His works, as they appear in this very careful and learned edition, include madrigals, *ballate*, *frammenti* and a *pescha* (that is, a fishing scene). An introduction of 43 p. discusses early Italian polyphony, LANDINO's life, the ms. sources, musical notation, forms and style, the instruments and the system of transcription. It is a notable contribution to our knowledge of fourteenth century music. To underline LANDINO's importance it will suffice to remark that he is responsible for over one third of the Italian music of that century which has come to us. His contemporaries honored him, witness the beautiful tombstone representing him with an *organetto*, which can still be seen in San Lorenzo. It bears a Latin inscription the sense of

which is " Deprived of the light, Francesco, whom alone Music extolls above all others for his great intellect and his organ music, rests his ashes here, his soul above the stars." This elaborate study was very handsomely lithoprinted in Ann Arbor, Michigan. G. S.

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It is AL-QALQASHANDĪ's reference in the *Ṣubḥ al-a'shâ* (vol. 5, 297) to the death of the Mandingo king JĀZA (or Jâta, Diata) who died of the sleeping sickness ca. 1373-75. MEYERHOF does not seem to be aware that IBN KHALDÛN refers to the very same fact in his history of the Berbers (Cairo ed., vol. 6, 202, DE SLANE's translation 2, 115). IBN KHALDÛN's work was probably written before AL-QALQASHANDĪ's, but for practical purposes they should be considered contemporary authorities, their statements being probably derived from the same written or oral tradition. The earliest mention of Trypanosomiasis in European medical literature is credited to the English naval surgeon JOHN ATKINS (1685-1757). G. S.

Sarton, George. Query no. 82. JOHN DE CASALI (fl. 1346-1375). *Isis* 30, 509, 1939. ISIS

Tanfani, Gustavo. ANTONIO, UGUCCIONE, ed ENRIGETTO DA RIO medici padovani " doctores Parisienses." *Rivista di storia delle scienze* 30, 49-55, 1939. ISIS

Wickersheimer, Ernest. Faits cliniques observés à Strasbourg et à Haslach en 1362 et suivis de formules de remèdes. *Bulletin de la Société française d'histoire de la médecine* 33, 69-92, 1939. ISIS

Whitmore, Mary Ernestine. Medieval English domestic life and amusements in the works of CHAUCER. XI+279 p. Washington, D.C., Catholic Univ. of America, 1937. ISIS

XVth Century (whole and first half)

Alberti, Leon Battista (1404-1472). De re aedificatoria libri decem. In two volumes, I : Text, XXIX+391 p., port., facs., figs. II, Materials and commentaries. XV+794 p., port., facs., figs., pl. Classics of the theory of architecture. Moscow, All-Union Academy of Architecture, 1935, 1937 (in Russian). ISIS

Reviewed by A. POGO, *Isis* 30, 523-25, 1939.

Benedict, Ralph C. The first experiment in plant physiology. *Science* 89, 411-12, 1939. ISIS

Apropos of the experiment commonly ascribed to J. B. VAN HELMONT but anticipated by CUSANUS and F. BACON. G. S.

Dept, G. G. Étude critique sur une grande inondation marine à la côte flamande (19 novembre 1404). *Études d'histoire dédiées à la mémoire de* HENRI PIRENNE, 20 p., Bruxelles, 1937. ISIS

The author, professor at the University of Ghent, is preparing a history of the Flemish polders, which will include a critical catalogue of the floods which occurred in Flanders. This paper is devoted to one of those floods. Why has the one of 19 Nov. 1404 been chosen? " Non seulement parce qu'elle est la première en date pour laquelle nous avons une abondante documentation de réelle utilité, mais encore parce qu'elle est une des plus importantes du Moyen Age, une de celles qui ont contribué le plus à modifier l'aspect de la Flandre du Nord." Elaborate study based on the sources. G. S.

Fischer, J. Die zur CUSANUS-Karte gehörige *Descriptio Germaniae modernae*. Herausgegeben und übersetzt von J. FISCHER. (Kartographische Denkmäler der Sudetenländer, 10). Geographisches Institut der Deutschen Universität in Prag, 8 p., 1 pl., 1936. ISIS

Gutkind, Curt S. COSIMO DE' MEDICI, pater patriae, 1389-1464. New York, Oxford University Press, 1938. ISIS

Latronico, Nicola. Una poesia sulla podagra del sec. XV nel cod. Vat. Reg. Lat. 1474. *Rivista di storia delle scienze* 30, 56-70, 1 fig., 1939. ISIS

Latin poem on gout by ANTONIO ASTESANO (c. 1412-c. 1464) " ANTONIS ASTENSIS versus in podagram." G. S.

XVth Century (second half)

Beksan, Fuat Kâmil. La comparaison du Traité de Chirurgie de CHEREFEDDIN SABOUNDJOUOGLOU avec celui d'ABULKASIM AZ-ZAHRAVI. *Türk tib tarihi arkivi* 3, 98-101, 1939. ISIS

Friedenwald, Harry. ABRAHAM ZACUTUS. *Bulletin of the History of Medicine* 7, 458-84, 3 fig., 1939. ISIS

Gersão Ventura, Augusta Faria. O " Regimento de Munich " e o enigma da sua penúltima página. *Petrus Nonius* 2, 140-47, 1939. ISIS

Kristeller, Paul Oscar. Florentine Platonism and its relations with humanism and scholasticism. *Church history* 8, 3-13, 1939. ISIS

" We conclude that besides the influence of PLATO and the Neoplatonists, and besides the modern motives suggested to FICINO by his century and by his own personality, there was a third element in his thought, *i.e.*, the medieval, scholastic tradition. This fact could also be derived from his other works, but it is seen more clearly from his newly discovered early tracts. His own feeling suggested to FICINO the general tendency of his speculation, the starting points, the preference for certain problems; to PLATO and the Neoplatonists he owed many propositions, formulas, speculative solutions; but from the scholastic tradition he took many of the forms of his thinking, especially the metaphysical terminology and the logical method or procedure of his argumentation. This fact is wholly in accordance with the laws of historical process. Humanism began as a non-philosophical reaction against scholasticism, and in order to become philosophical speculation, it had to absorb the scholastic tradition of the Middle Ages."

Moreland, W. H. (†) The ships of the Arabian Sea about A.D. 1500. Appendix by RICHARD BURN. *Journal of the Royal Asiatic Society* 173-92, 1939. ISIS

Nowell, Charles E. The COLUMBUS question. A survey of recent literature and present opinion. *American Historical Review* 44, 802-22, 1939. ISIS

(Pius II). The Commentaries of PIUS II. Translation by FLORENCE ALDEN GRAGG. With historical introduction and notes by LEONA C. GABEL. 114 p. (*Smith College Studies in History* 22, nos. 1-2). Northampton, 1936-37. ISIS

Ünver, A. Süheyl. Les illustrations du traité de chirurgie de CHEREFEDDIN SABOUNDJOUOGLOU. 77 p., illus. T. C. Istanbul Üniversitesi, *Tib Tarihi Enstitüsü*, no. 12, 1939 (in Turkish with French summary). ISIS

" *Djerrahiyei Ilhaniye* possède les points principaux du livre de EBOULKASIM ZAHRAVÎ. Ce traité est présenté sous forme d'un bel ouvrage enrichi des idées de l'auteur et de dessins d'instruments chirurgicaux et fut écrit, en 879 (1465), par SABOUNDJOUOĞLOU CHÉREFETTIN, fils de ALI, qui occupa le poste de chirurgien de l'hôpital d'Amasya pendant 14 ans. Il n'existe aujourd'hui dans le monde entier que deux exemplaires de ce livre écrit avec l'écriture de l'auteur. L'un des deux se trouve actuellement dans le musée de la bibliothèque de nation à Fatih, parmi les livres de ALI EMÎRI au numéro (79). Cet ouvrage est illustré mais possède quelques lacunes sur certains sujets. Mais il en existe un exemplaire complet à la bibliothèque

nationale de Paris au numéro supp. turc 693. Ce livre qui fut offert en 1277 (1869) au médecin Français BERGERON par MEHMED ALI YASINDJI ZADÉ, membre du Medjlisi Tanzimat, fut ensuite donné à la bibliothèque royale, aujourd'hui bibliothèque nationale de Paris. Cette copie qui est complète possède quelques illustrations qui manquent à l'exemplaire d'Istanbul. Les illustrations des deux copies sont faites par le même artiste. Il n'y a pas de signature; mais nous pensons qu'elles appartiennent à l'auteur, car un médecin peut dessiner de cette façon. Il n'est pas étonnant que CHÉREFETTIN qui connaît la technique du dessin simple soit l'auteur de ces illustrations. Le livre est également intéressant au point de vue de la langue turque. Nous voyons au XIV^e^ siècle le commencement des traductions, des adaptations et compositions de livres en Turc en Anatolie. Ce langage scientifique et plus spécialement le médical est plus travaillé au XV^e^ siècle. Outre les quelques mots arabes et persans, le livre en question est écrit dans le langage turc simple et clair. Cette œuvre que j'ai eu l'occasion d'étudier spécialement pour la Société de langue turque, représente l'un des plus beaux exemples de la vraie littérature turque." Les illustrations du Ms. de Paris sont fort bien reproduites. G. S.

van de Walle, B. Une version manuscrite du célèbre voyage de JOSSE DE GHISTELLES en Orient (1481-1485). *Chronique d'Egypte* 14, 245-57, 1939. ISIS

XVIth Century (whole and first half)

B. — *Physical sciences and technology*

Armitage, Angus. COPERNICUS. The founder of modern astronomy. 183 p., frontispiece. (History of science library). London, ALLEN & UNWIN, 1938 (10 s.). ISIS

" The plan of the book is as follows. By way of introduction to the work of COPERNICUS, it has been necessary to summarize the development of planetary theories from Babylonian times down to his day. This is done in Chapter I. Chapter II contains a concise biography of COPERNICUS, with some account of his instruments and of the results of the critical examination of his manuscripts. With Chapter III we begin the exposition of COPERNICUS' epoch-making work, the *De revolutionibus*. This occupies the rest of the book, except for a short Epilogue on the establishment of the heliocentric theory, and several supplementary notes. The *De revolutionibus* has been studied comparatively with PTOLEMY's *Almagest*, and I have inserted numerous references to the latter in order to bring out the close connection between the two works."

McColley, Grant. The universe of *De revolutionibus*. *Isis* 30, 452-72, 1939. ISIS

" As we stand on the threshold of the quatercentenary of the *Narratio*

prima and approach that of the publication of *De revolutionibus*, it is desirable to re-examine a variety of related conclusions regarding the beliefs and contributions of COPERNICUS. Specifically, it is necessary to call into question the traditional historical interpretations that COPERNICUS believed the stars were attached to a crystal or material shell, that he bounded the world with the Ptolemaic eighth sphere, and that either THOMAS DIGGES or GIORDANO BRUNO was the first to ' shatter the walls ' of the Ptolemaic cosmos and to make the idea of an infinite universe a corollary to the Copernican hypothesis."

Testi, Gino. I chimici militari italiani. Esplosivi, mine ed artiglierie nell' opera " De la pirotechnia " del senese VANNOCCIO BIRINGUCCIO (1480-1539). *Bollettino dell' Istituto storico e di cultura dell'Arma del Genio*, No. 8, 1938. ISIS

Zinner, Ernst. New light upon COPERNICUS. *Research and progress* 4, 135-40, 1938. ISIS

C. — *Natural sciences*

Abyssinia. The discovery of Abyssinia by the Portuguese in 1520. A facsimile of the relation entitled *Carta das novas que vieram a el Rey nosso Senhor do descobrimento do preste Joham* (Lisbon, 1521), with an introduction and English translation and notes by HENRY THOMAS, and a transcription into modern Portuguese by ARMANDO CORTESÃO. XV+98 p., facs., 2 maps. London, British Museum, 1938. ISIS

Reviewed by A. POGO, *Isis* 30, 525-29, 2 figs., 1939.

Coutinho, Gago. Nota sôbre a inscrição irregular da pedra de Dighton. *Petrus Nonius* 2, 123-26, 1939. ISIS

De Sousa, J. M. Cordeiro. A inscrição portuguesa da pedra de Dighton. *Petrus Nonius* 2, 121-22, 1939. ISIS

Tooley, R. V. Maps in Italian atlases of the sixteenth century, being a comparative list of the Italian maps issued by LAFRERI, FORLANI, DUCHETTI, BERTELLI and others, found in atlases. *Imago Mundi* 3, 12-47, 1939. ISIS

Uhden, Richard. The oldest Portuguese original chart of the Indian Ocean, A.D. 1509. *Imago Mundi* 3, 7-11, 1 map, 1939. ISIS

D. — *Medical sciences*

Baradlai, D. PARACELSI Reisen und Abenteuer in Ungarn. *Die Vorträge der Hauptversammlung in München*, Oktober, 1938, Gesellschaft für Geschichte der Pharmazie, p. 79-84. ISIS

Crummer, Le Roy (1872-1934); **Saunders, John B. de C. M.** The anatomical compendium of LOYS VASSE (1540). *Annals of medical history* 1, 351-69, 7 fig., 1939. ISIS

Mayer, Claudius F. Specimen pages from a Bio-bibliography of XVIth century medical authors. 20 p. (Fourth series of the Index-Catalogue of the Library of the Surgeon General's Office, vol. 4, 1939). Washington, D.C. ISIS

Isis greets this most useful undertaking with special pleasure, for her editor has often regretted that too much attention was paid to incunabula vs. sixteenth century books which are in many respects more important. See his remarks in *Scientific incunabula* (*Osiris* 5, 90, 1939). The specimen pages make a very favorable impression. The amount of information given (biography, description, illustration) seems very well balanced. G. S.

(Paracelsus). PARACELSUS collection made by CONSTANTINE HERING (1800-80) described in *Hospital tidings*, Philadelphia, Nov. 1935, p. 5-9. ISIS

Sandri, Gino. Il sepolcro di GIROLAMO FRACASTORO. *Bollettino della Società letteraria di Verona*, no. 2, 7, 1938. ISIS

Slaughter, Donald. Medicine in the life of FRANÇOIS RABELAIS. *Annals of medical history* 1, 396-401, 2 fig., 438-51, 5 fig., 1939. ISIS

E. — *Alia*

Chambers, R. W. THOMAS MORE. 416 p., 8 illus. London, CAPE, 1935. ISIS

This is a great biography of one of the greatest men, Saint THOMAS MORE. There were four outstanding humanists in that time: ERASMUS, VIVES, BUDÉ, and MORE, but the latter was the greatest of them. The book is timely, for we have to save Europe from dictatorships, as MORE tried to do in his conflict with the criminal king, HENRY VIII, almost as vile as the dictators of our own time. G. S.

Elie, Hubert. Le traité " De l'infini " de JEAN MAIR. Nouvelle édition avec traduction et annotations. XXIII+244 p. Paris, VRIN, 1937. ISIS

Frick, Bertha. GREGORIUS REISCH (German Carthusian, encyclopaedist, d. Freiburg 1523). *Isis* 30, 510, 1939. ISIS

Important correction to SARTON's *Scientific incunabula* (*Osiris* 5, p. 193, 1938). The first edition of the *Margarita philosophica* appeared in 1503, not 1496.

XVIth Century (second half)

A. — *Mathematics*

Bompiani, Enrico. Alcune costruzioni di coniche. *Bollettino della Unione matematica italiana* 1, 372-73, 1939. ISIS

" Si ricorda una costruzione di GUIDUBALDO DEL MONTE per l'ellisse e se ne dà una analoga per l'iperbole."

Richeson, A. W. Notes on an unpublished manuscript of VALENTIN ENGELHARDT. *Scripta mathematica* 6, 26-31, 1939. ISIS

C. — *Natural sciences*

Ch'en, Kenneth. MATTEO RICCI's contribution to, and influence on, geographical knowledge in China. *Journal of the American Oriental Society* 59, 325-59, 1939. ISIS

Fink, Colin G.; Polushkin, E. P. DRAKE's plate of brass authenticated : the report on the plate of brass. With a foreword by ALLEN L. CHICKERING and a biographical note on Professor FINK by JOEL H. HILDEBRAND. 28 p., 49 pls. San Francisco, California Historical Society, 1938. ISIS

Frobisher, Martin. The three voyages of MARTIN FROBISHER. Edited by VILHJALMUR STEFANSSON, with the collaboration of ELOISE MCCASKILL. 2 vols., CXXX+166 p.; VIII+293 p., illus., maps. London, Argonaut Press, 1938. ISIS

Reviewed by FRANCIS R. JOHNSON, *Isis* 30, 284-89, 1939.

Parsons, E. J. S.; Morris, W. F. EDWARD WRIGHT and his work. *Imago Mundi* 3, 61-71, 1939. ISIS

Primrose, J. B. Earliest Indian printed book. *Times Literary Supplement*, p. 556, 2 pl., London, September 23, 1939. ISIS

The earliest book printed in India is not the *Coloquios dos simples e drogas*

of GARCIA DA ORTA issued in Goa, 1563 (*Isis* 2, 415-18), but a *Compendio spiritual* printed in Goa, 1561, composed by Dom GASPAR DE LEÃO PEREIRA, first archbishop of that city. G. S.

(**Ricci**). MATTEO RICCI's world map in Chinese, 1602. A collotype reproduction. Society of Chinese Historical Geography, Peiping, 1936. ISIS

Richter, Herman. WILLEM JANSZ. BLAEU with TYCHO BRAHE on Hven, and his map of the Island : some new facts. *Imago Mundi* 3, 53-60, 1 facs., 5 fig., 1939. ISIS

Schwerz. GESNER oder GESSNER? *Mitteilungen zur Geschichte der Medizin, der Naturwissenschaften und der Technik* 38, 231, 1939. ISIS

Taylor, E. G. R. HUDSON's Strait and the oblique meridian. *Imago Mundi* 3, 48-52, 7 fig., 1939. ISIS

Whitaker, Harold. The later editions of SAXTON's county maps. *Imago Mundi* 3, 72-86, 1939. ISIS

D. — *Medical sciences*

Bertram, Hans. Vorschriften aus dem 16. Jahrhundert über das Verhalten bei Pestseuchen. *Janus* 43, 137-43, 1939. ISIS

Draper, John W. The choleric Cassio. *Bulletin of the history of medicine* 7, 583-94, 1939. ISIS

Giordano, Davide. Della fame, che hanno gli uomini, di anni. Discorso ufficiale letto alla Adunanza Solenne, nella Sala de' Pregadi li 12 Giugno, 1932. 27 p. R. Istituto Veneto di scienze, lettere ed arti. Venezia, 1932. ISIS

Dealing partly with the famous theoretician of macrobiotics, LUIGI CORNARO, whose birth and death dates are given as 1467-1565. Senator GIORDANO has just honored me with a letter (Sept. 2, 1939) wherein he declares that the dates established by Prof. VITTORIO ROSSI are now considered the most probable, that is, 1475 and May 8, 1566. Thus CORNARO was ninety-one when he died. G. S.

Ünver, A. Süheyl. La mort par suite de la peste (?) du fils du Voivode de Moldavie (1495). *Türk tib tarihi arkivi* 3, 149-53, 2 fig., 1939. ISIS

Zíbrt, Čeněk. Staročeská tělověda a zdravověda. S původními obrázky podle rukopisův a knih staročeských i cizích. (Old Czech anatomy and hygiene). 391 p., 94 fig. Praha, Nákladem Vydavatelství "Sfinx," 1924 (in Czech). ISIS

Elaborate study of old Czech anatomy and medicine down to the second half of the eighteenth century. The kernel of the book is provided by the Ms. anatomy of PHILOMATHES MATTHAEUS A DAČICK : *Divná fabrika a složení lidského těla*, 1574 (Wonderful fabric and arrangement of the human body). Abundant Czech glossary and index. G. S.

XVIIth Century (whole and first half)

A. — *Mathematics*

Bortolotti, Ettore. I primi algoritmi infiniti nelle opere dei matematici italiani del secolo XVII. *Bollettino della unione matematica italiana* 1, 351-71, 1939. ISIS

"Lo sviluppo in serie di irrazionalità quadratiche, e la scoperta delle frazioni continue (P. A. CATALDI). La somma di serie infinite (E. TORRICELLI, P. MENGOLI)."

Bortolotti, Ettore. L'opera geometrica di EVANGELISTA TORRICELLI. *Monatshefte für Mathematik und Physik* 48, 457-86, 23 fig., 1939. ISIS

Roth, Leon. DESCARTES' Discourse on Method. VIII+142 p. Oxford, Clarendon Press, 1937. ISIS

Saltykow, N. Correction de la solution donnée par DESCARTES au problème de PAPPUS. *Bulletin de l'Académie des Sciences mathématiques et naturelles*, A. *Sciences mathématiques et physiques*, no. 5, 71-74, Belgrade, 1939. ISIS

Saltykow, N. DESCARTES' correction to the solution of PAPPUS' problem. *R. Serbian Academy, math. section*, 178, 129-35, Belgrade, 1939 (in Serbian). ISIS

B. — *Physical sciences and technology*

Haden, Russell L. The origin of the microscope. *Annals of Medical History* 1, 30-44, 15 fig., 1939. ISIS

Houstoun, R. A. KEPLER's law of refraction. *Nature* 144, 441, 1939. ISIS

Pettit, Edison. A telescope of GALILEO. *Publications of the Astronomical Society of the Pacific* 51, 147-50, 1 pl., 1 fig., 1939. ISIS

In 1923 HALE and ABETTI made a careful study of the larger of the two telescopes attributed to GALILEO which are kept in the Florence Museum of Ancient Instruments, and had an accurate replica made. PETTIT gives detailed scale drawings for constructing such a replica. This paper is one of the few in which a thoroughly satisfactory and complete account is given of the dimensions and structural design of this historic instrument. D. N.

D. — *Medical sciences*

James, R. R. Dr. THOMAS GRENT, Sen. and Jun. *Janus* 43, 131-36, 1939. ISIS

Koltermann, Johannes. Der Ausbruch der Pest in der Neustadt Hanau 1605. *Archiv für Geschichte der Medizin* 32, 110-20, 1939. ISIS

Meyerhof, M.; Rogge, H. C. Medizinisches aus Reisebeschreibungen nach Niederländisch-Indien im siebzehnten Jahrhundert. *Janus* 43, 92-122, 1939. ISIS

Pfeilsticker, Walther. LOUISE BOURGEOIS. *Archiv für Geschichte der Medizin* 32, 1-20, 6 fig., 1939. ISIS

Silvette, Herbert. On quacks and quackery in seventeenth century England. *Annals of Medical History* 1, 239-51, 1939. ISIS

Tallmadge, G. Kasten. PIERRE GASSENDI and the *Elegans de septo cordis pervio observatio*. *Bulletin of the history of medicine* 7, 429-57, 2 fig., 1939. ISIS

Zürbach, Karl. WILLIAM HARVEY's discovery of the circulation of the blood. *Ciba Symposia* 1, 78-86, figs., 1939. ISIS

E. — *Alia*

Lyon, T. The theory of religious liberty in England, 1603-1639. VIII+241 p. (Thirlwall prize essay, 1937). Cambridge, University Press, 1937. ISIS

Miller, Perry. The New England mind. The seventeenth century. XI+528 p. New York, MACMILLAN, 1939. ISIS

This book is a topical analysis of various leading ideas in colonial New England rather than a history of their development. It is offered as the first volume in a projected series upon the intellectual history of New England to extend through the eighteenth and early nineteenth centuries. Of most interest to readers of *Isis* is Book II, *Cosmology*, especially the chapter on *Nature*, which consists of an excellent summary of the state of science in colonial New England and its place in the intellectual climate generally.
I B. C.

Nobbs, Douglas. Theocracy and toleration : a study of the disputes in Dutch Calvinism from 1600 to 1650. XIV+280 p. Cambridge University Press, 1938. ISIS

Sarton, George. Third preface to volume XXX. COMENIUS redivivus. *Isis* 30, 425-51, 20 fig., 1939. ISIS

XVIIth Century (second half)

A. — *Mathematics*

Pelseneer, Jean. Lettres inédites de NEWTON. *Osiris* 7, 522-55, 3 facs., 1939. ISIS

Scott, J. F. The mathematical work of JOHN WALLIS, D.D., F.R.S. (1616-1703). With a foreword by E. N. DA C. ANDRADE. XI+240 p., figs., facs., port. London, TAYLOR and FRANCIS, 1938. ISIS

Reviewed by I BERNARD COHEN, *Isis* 30, 529-32, 1939.

Yule, G. Udny. JOHN WALLIS, D.D., F.R.S. (1616-1703). *Notes and Records of the Royal Society*, 73-82, port., April 1939. ISIS

Apropos of J. F. SCOTT's recent book on WALLIS (1938) for which see *Isis* 30, 529-32, 1939. I B. C.

B. — *Physical sciences and technology*

Dept, G. G. Een polemiek over de werking van ebbe en vloed (midden der XVIIde eeuw). *Tijdschrift van de Belgische Vereeniging voor Aardrijkskundige Studies* 8, 84-94, 1938. (In Dutch with résumé in French). ISIS

" Au milieu du XVII^e siècle parurent toute une série d'opuscules pour remédier à l'ensablement au port d'Ostende. Dans deux de ces pamphlets MICHEL F. VAN LANGREN, cosmographe du roi d'Espagne, tenta de prouver que l'eau de mer qui se trouve sous la ligne des basses eaux est immobile et pas attirée par la lune. Ses adversaires COECK, JANSSEN et MERCX eurent

beau jeu de montrer dans une ' Apologie ' qu'il n'est pas possible d'admettre ce point de vue. Nous reproduirons ces textes en appendice parce qu'ils sont devenus rarissimes, qu'ils nous font saisir sur le vif la naïveté de certaines conceptions géographiques au milieu du XVII[e] siècle et qu'ils prouvent par surcroît l'influence de la lutte contre la mer en Flandre sur les idées scientifiques."

Duhem, Jules. Un capucin aéronaute. Essai sur un curieux livre publié en 1676 par Fray ANTONIO DE FUENTE LA PEÑA. *Mercure de France* 291, 565-73, 1939. ISIS

D. — *Medical sciences*

Goldman, Leon. MOLIÈRE and his own illness. *Annals of medical history* 1, 370-73, 1939. ISIS

Lockemann, Theodor. EISENBART in Jena. *Archiv für Geschichte der Medizin* 32, 93-94, 1939. ISIS

Napjus, J. W. De hoogleeraren in de geneeskunde aan de Hoogeschool en het Athenaeum te Franeker (1585-1843). XIII. ABRAHAM CYPRIANUS. Part II (conclusion). *Bijdragen tot de geschiedenis der geneeskunde* 19, 159-65, 1939. ISIS

Ünver, A. Süheyl. Les idées du médecin turc CHABAN CHIFAI et de EUMER HAYYAM. *Türk Tib Tarihi Arkivi* 3, 4 p., 1938 (in Turkish, with summary in French). ISIS

E. — *Alia*

Ashley-Montagu, M. F. The conscience of the past and the practise of the present. *Science* 90, 180, 1939. ISIS

Apropos of Father FRANCESCO LANA (d. 1687). G. S.

Cidade, Hernâni. D. RAFAEL BLUTEAU. O Alvorecer do " Século das Luzes " em Portugal. *Petrus Nonius* 2, 104-16, 1939. ISIS

Gunther, R. T. Early science in Oxford. Vol. XII, Dr. PLOT and the correspondence of the Philosophical Society of Oxford. XVII+ 434 p., 11 illus. Oxford, 1939. ISIS

Jordan, Wilbur Kitchener. The development of religious toleration in England from the convention of the Long Parliament to the Restoration, 1640-1660 : the revolutionary experiments and dominant

religious thoughts. 560 p. Cambridge, Harvard University Press, 1938.

Josson, H.; Willaert, L. Correspondance de FERDINAND VERBIEST (1623-1688) de la Compagnie de Jésus, directeur de l'Observatoire de Pékin. XXIV+591 p. (Commission royale d'histoire). Brussels, Palais des Académies, 1938. ISIS

Malebranche. Numéro spécial du *Bulletin de la Société française de Philosophie* 38, 77-116, 1938. ISIS

Contains articles by LÉON BRUNSCHVICG, ANDRÉ CHAUMEIX, ÉMILE PICARD, ÉDOUARD LE ROY, DÉSIRÉ ROUSTAN, HENRI GOUHIER, and PAUL SCHRECKER.

McColley, Grant. MILTON's golden compasses. *Notes & Queries*, 1 p., Feb. 11, 1939. ISIS

McColley, Grant. Paradise lost. *Harvard theological review* 32, 181-235, 1939. ISIS

" Among the significant questions perennially raised by Miltonic criticism, the two most important are the two most variously answered : What is *Paradise Lost*, and did MILTON write it? If the evidence which follows may be regarded as sufficiently exhaustive, I suggest that *Paradise Lost* was designed as a non-sectarian epic and more or less deliberately modelled as well as based upon conservative religious literature. The second conclusion is that MILTON wrote his greatest poem to justify the ways of the Christian God, and to give artistic-prophetic expression to beliefs which were both vital and sacred to him."

Watson, E. C. The early days of the *Académie des Sciences* as portrayed in the engravings of SÉBASTIEN LE CLERC. *Osiris* 7, 556-87, 18 fig., 1939. ISIS

Watson, E. C. EDME MARIOTTE (c. 1620-1684). *The American Physics Teacher* 7, 230-32, 2 pl., 1939. ISIS

Willcox, Walter F. The founder of statistics. *Revue de l'Institut international de statistique*, 8 p., 1937. ISIS

" GRAUNT is memorable mainly because he discovered the numerical regularity of deaths and births, of the ratios of the sexes at death and birth, and of the proportion of deaths from certain causes to all deaths in successive years and in different areas; or in general terms, the uniformity and predictability of many important biological phenomena taken in the mass. In doing so he opened the way both for the later discovery of uniformities in

many social or volitional phenomena like marriage, suicide and crime, and for a study of these uniformities, their nature and their limits; thus he, more than any other man, was the founder of statistics."

XVIIIth Century (whole and first half)

B. — *Physical sciences and technology*

Bining, Arthur Cecil. Pennsylvania iron manufacture in the eighteenth century. 227 p. Harrisburg, Pennsylvania Historical Commission, 1938. ISIS

Kilgour, Frederick G. THOMAS ROBIE (1689-1729), colonial scientist and physician. *Isis* 30, 473-90, 6 fig., 1939. ISIS

" ROBIE's importance lies in the fact that he added to the prestige of science, and kept it going in a society that had been forced into a strictly utilitarian way of living. He advanced scientific activity in New England, and cut down the weeds of superstition. The real significance of ROBIE as a scientist lay not only in his individual achievements but also in his position in that Harvard stream of science which flowed through THOMAS BRATTLE, THOMAS ROBIE and ISAAC GREENWOOD, and which burst forth under the aegis of Professor JOHN WINTHROP."

Kotsakis, D. Die Astronomie in Griechenland im 18. Jahrhundert. *Meddelande fran Lunds Astronomiska Observatorium*, ser. II, no. 101, Historical notes and papers, no. 15, 5 p., Lund, Sweden, 1939. ISIS

(Swedenborg, Emanuel). SWEDENBORG's *Treatise on copper* (*Opera philosophica et mineralia*, vol. 3). Translated into English by ARTHUR HODSON SEARLE. Section 1 : Being chapters I-XIX of part 1 of original, XVIII+180 p. Section 2 : Being chapters XX-XLIX of part 1 of original, III+181+348 p. Section 3 : Being chapters L-LIII of part 1 : part 2 (chapters I-IV) and part 3 (chapters I-XII) of original ; with index, IV+349-536 p. (British Non-Ferrous Metals Research Association, miscellaneous publication no. 333). London, 1938. ISIS

C. — *Natural sciences*

Falls, William F. BUFFON et les premières bêtes du Jardin du Roi : histoire ou légende ? *Isis* 30, 491-94, 1939. ISIS

(Linnaeus). Caroli Linnaei Systema naturae. A photographic facsimile of the first volume of the tenth edition (1758). Regnum animale.

824 p. London, British Museum (Natural History), 1939. (10/6). ISIS

" Original copies of the tenth edition of the *Systema Naturae* are extremely rare, and the reprint made by the Deutsche Zoologische Gesellschaft in 1894 is also difficult to obtain. As the tenth edition of LINNAEUS's great work is of constant and fundamental importance for the systematic zoologist, the present photographic reproduction of Tomus I (Regnum Animale) has been undertaken in the belief that it will be of value to all who are occupied with problems of zoological nomenclature."

(Linnaeus). The " Critica botanica " of LINNAEUS. Translated by Sir ARTHUR HORT. Revised by M. L. GREEN. XXVII+239 p. (Ray Society series, no. 124). London, QUARITCH, 1938. ISIS

Rabel, Gabrielle. Long before DARWIN. LINNÉ's views on the Origin of species. *Discovery* 2, 121-26, 170-75, 1939. ISIS

Rödiger, Johannes. Darstellung der geographischen Naturbetrachtung bei FONTENELLE, PLUCHE und BUFFON in methodischer und stilistischer Hinsicht. (Inaugural-Dissertation). VIII+130 p. Leipzig, FISCHER, 1935. ISIS

Vogel, J. Ph. Journaal van J. J. KETELAAR's hofreis naar den groot Mogol te Lahore, 1711-13. XXVII+454 p., 20 pl., 3 ills., 1 map. The Hague, NIJHOFF, 1937. ISIS

D. — *Medical sciences*

Boerhaave, Herman. Memoralia. Optimi medici. Haarlem, BOHN, 1939. ISIS

Cothenius, Christian Andreas (1708-1789). Biography with bibliography, by EDITH HEISCHKEL, *Pommersche Lebensbilder* 3, 39-47, port. (received Oct. 1939). ISIS

Diepgen, Paul. HERMANN BOERHAAVE und die Medizin seiner Zeit mit besonderer Berücksichtigung seiner Wirkung nach Deutschland. *Hippokrates* H. 12, 289-306 ; H. 14, 345-51, 1939. ISIS

Irissou, Louis. Le singulier dédoublement de PIERRE RIDEUX (1674-1750). *Bulletin de la société française d'histoire de la médecine* 33, 103-08, 1939. ISIS

Mursinna, Christian Ludwig (1744-1823). Biography with bibliography by EDITH HEISCHKEL. *Pommersche Lebensbilder* 3, 151-60, port. (received Oct. 1939). ISIS

Renaud, H. P. J. La peste de Ceuta (1743-1744) d'après des documents inédits. *Quatrième congrès de la Fédération des sociétés savantes de l'Afrique du Nord*, 17 p., Alger (received Oct. 1939). ISIS

Rouffiandis. Un aspect de la condition des chirurgiens-majors des hôpitaux militaires en Roussillon, au XVIII[e] siècle. *Bulletin de la Société française d'histoire de la médecine*, 33, 93-102, 1939. ISIS

E. — *Alia*

Hastings, Hester. Man and beast in French thought of the eighteenth century. *Johns Hopkins studies in Romance literature and languages* 27, 297 p., 1936. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 532-33, 1939.

Ramsbottom, J. The Royal Swedish Academy of Science. Bicentenary celebrations. *Nature* 144, 270-71, 1939. ISIS

XVIIIth Century (second half)

B. — *Physical sciences and technology*

Brasch, Frederick E. Sir WILLIAM HERSCHEL, 1738-1822. *Popular astronomy* 47, 7 p., 1939. ISIS

(Priestley, Joseph). A portrait of JOSEPH PRIESTLEY, F.R.S., by JAMES MILLAR, 1789. *Notes and Records of the Royal Society* 32-33, port., April 1939. ISIS

Oseen, C. W. JOHAN CARL WILCKE, experimental-fysiker. 397 p., frontispiece. Uppsala, ALMQVIST & WIKSELL, 1939. ISIS

Elaborate biography published by the Swedish Academy of Sciences, of the great physicist JOHAN CARL WILCKE (1732-96) who was its secretary from 1784 to 1796. Unfortunately there is no summary in an international language, and this beautiful but bulky Swedish volume will not be read by many non-Swedish people. G. S.

C. — *Natural sciences*

Chinard, Gilbert. Voyage de LAPÉROUSE sur les côtes de l'Alaska et de la Californie (1786) avec une introduction et des notes. LII+

144 p., 22 pl. (Historical documents, Institut français de Washington, cahier 10). Baltimore, Johns Hopkins Press, 1937. ISIS

Reviewed by C. A. KOFOID, *Isis* 30, 533-35, 1939.

Larsen, Esther Louise. PETER KALM's Short account of the natural position, use and care of some plants, of which the seeds were recently brought home from North America for the service of those who take pleasure in experimenting with the cultivation of the same in our climate. *Agricultural history* 13, 33-64, 1939. ISIS

This is a translation of a 48-page pamphlet written by PEHR KALM. There is no title but a heading, " En Kårt Berättelse, om Naturliga stället, etc." The colophon reads " Stockholm, uplagdt på LARS SALVII kostnad [issued at LARS SALVIUS' expense], 1751." PRITZEL does not mention this pamphlet and it is not included in the KALM bibliography of A. B. BENSON. B. DAYTON JACKSON is of the opinion that it was published as a supplement of *Lärda Tidningar*, a well-known Swedish scientific journal of the 18th century. One hundred and twenty six plants are described with especial emphasis upon their utility. C. Z.

Moir, J. Reid. A pioneer in palaeolithic discovery. *Notes and Records of the Royal Society* 28-31, port., April 1939. ISIS

Apropos of JOHN FRERE (1797), with portrait. G. S.

Schierbeek, A. CAMPER en GOETHE over het tusschenkaaksbeen. *Nederl. Tijdschrift voor Geneeskunde* 83, 2128-33, 1939. ISIS

(Spallanzani, Lazzaro, 1729-1799). Celebration at Pavia. By F. A. E. CREW, *Nature* 143, 926-28, 1 fig., 1939. ISIS

D. — *Medical sciences*

Camper, Pieter (1722-89). Number of *Bijdragen tot de geschiedenis der geneeskunde* devoted to him. Vol. 19, 73-151, 2 pl., 3 fig., 1939. ISIS

Articles by G. VAN RIJNBERK, B. W. TH. NUYENS, R. A. B. OOSTERHUIS, G. F. ROCHAT, J. L. B. ENGELHARD, H. M. DE BURLET, L. D. EERLAND, J. J. TH. VOS, A. SCHIERBEEK, M. A. VAN ANDEL, J. WESTER, F. M. G. DE FEYFER.

Engelhard, J. L. B.; van Rijnberk, G.; Schoute, D. PETRUS CAMPER, April 7, 1789—150th anniversary of the death of PETRUS CAMPER. *Isis* 30, 510, 1939. ISIS

Fraatz, Paul. Tatsachenbericht über die gesundheitliche Beschaffenheit der Fürstin GALLITZIN. (Aus einem Vorträge anlässlich der Tagung der Deutschen Gesellschaft für Geschichte der Medizin usw. am 5.9 .1937 zu Koblenz). *Archiv für Geschichte der Medizin* 32, 120-35, 1939. ISIS

Hahnemann, C. F. S. (1755-1843). Description of the HAHNEMANN collection in Hahnemann Medical College. *Hospital tidings*, Philadelphia, Nov. 1935, p. 9-12. ISIS

Leikind, Morris C. An episode in the history of smallpox vaccination in New Hampshire. *Bulletin of the history of medicine* 7, 671-86, 2 figs., 1939. ISIS

Pensa, A. L' " epistolario di ANTONIO SCARPA." *Rivista di storia delle scienze* 30, 103-04, 1939. ISIS

Apropos of *Epistolario di* ANTONIO SCARPA, 883 p. Pavia, Tip. già Cooperativa, 1938. I B. C.

Selle, Christian Gottlieb (1748-1800). Biography with bibliography by EDITH HEISCHKEL. *Pommersche Lebensbilder* 3, 161-69, port. (received Oct. 1939). ISIS

Urdang, George. The Lititz pharmacopoeia. *American journal of pharmaceutical education* 3, 281-84, 1939. ISIS

Apropos of EDWARD KREMERS' edition and translation of that text in *The Badger pharmacist* 1938. G. S.

XIXth Century (whole and first half)

A. — *Mathematics*

Dunnington, G. Waldo. Notes on LEJEUNE DIRICHLET. *National Mathematics Magazine* 12, 12 p., figs., 1938. ISIS

Loria, Gino. CHARLES STURM et son œuvre mathématique (1803-1855). *L'enseignement mathématique* 37, 249-74, 1 port., 1938. ISIS

Nagel, Ernest. The formation of modern conceptions of formal logic in the development of geometry. *Osiris* 7, 142-224, 1939. ISIS

" This paper discusses developments in pure geometry during the 19th century and their incidence upon some central ideas of modern logic."

B. — *Physical sciences and technology*

Anft, Berthold. FRIEDLIEB FERDINAND RUNGE, sein Leben und sein Werk. 207 p. (*Abhandlungen zur Geschichte der Medizin und der Naturwissenschaften*, 23). Berlin, EBERING, 1937. ISIS

Bouchard, Georges. CHEVREUL (1786-1889), le doyen des savants qui vit au cours d'un siècle quatre rois, deux empereurs, trois républiques, quatre révolutions. 209 p. Paris, Éditions de la Madeleine, 1932. ISIS

Excellent biography, well documented and very readable, of one of the founders of organic chemistry. The personality of CHEVREUL is interesting in many respects. He is the most remarkable example of longevity in the whole history of science, for he lived to be 103, witnessed in his own country "four kings, two emperors, three republics and four revolutions" and continued his work almost until the end of his days. This book is the more remarkable in that the author is not a professional historian but an industrialist. Our readers are already acquainted with his biography of GUYTON-MORVEAU (Paris 1938). G. S.

Dubois, G. L'industrie de la distillation au siècle dernier. Origine de la colonne continue. *Revue générale des applications industrielles*, 20 p., 10 fig., Bruxelles, 1939. ISIS

"History of distillation plants devised in the XIXth century, particularly that of the distillating column. This invention is due to CELLIER-BLUMENTHAL, a French engineer (1768-1840). The relation of the coppersmith profession to this branch is alluded to."

Eberhard, A. LIEBIG als Apothekenvisitator und die nachfolgende Neuorganisation des Besichtigungswesens im ehemaligen Grossherzogtum Hessen. *Die Vorträge der Hauptversammlung in München*, October, 1938. Gesellschaft für Geschichte der Pharmazie, p. 99-107. ISIS

Holmberg, Arne. Portraits du chimiste suédois, J. J. BERZELIUS (1779-1848). Illustrations et descriptions publiées au nom de l'Académie Royale des Sciences de Suède. XVI+52 p., frontispiece, 32 pl., 35 fig. Stockholm, 1939 (in Swedish with summary in French). ISIS

Elaborate and richly illustrated iconography of the Swede, BERZELIUS, who was one of the greatest chemists of his time. It is written in Swedish but there is a French summary and the legends of the abundant illustrations are easy enough to understand. Should be added to the list of iconographic studies printed in *Isis* 30, 230-32, 1939. G. S.

Mittasch, A. SCHOPENHAUER und die Chemie. 92 p. Heidelberg, WINTER, 1939 (RM. 2.50). ISIS

Dr. MITTASCH, known particularly for his work on catalysis, on its theory and on its practical application in chemical engineering, on its history, and on its background and implications, is to be reckoned among the more philosophical of the contemporary chemists who are writing on the history of chemistry. The present work, reprinted from the 26th Yearbook of the Schopenhauer-Gesellschaft, 1939, consists of four principal parts, which deal respectively with SCHOPENHAUER's knowledge of the chemistry of his time, with his view of the significance and importance of chemistry, with his philosophy of chemistry, and with the significance for the future of SCHOPENHAUER's philosophy of chemistry. The reviewer does not see that SCHOPENHAUER made greater use of the chemistry of his time than did other contemporaneous alert and intelligent thinkers. The conclusions that " the world is too much with us soon and late; getting and spending we lay waste our powers," that " the moving finger writes and having writ moves on," may be reached without an appeal to the laws of the conservation of mass and of energy. The concepts and jargon of science are used in our own times to support conclusions which may be reached more clearly by less devious methods. MITTASCH's book supports the conviction that the history of thought and the history of science are one and the same. It will be of interest especially to students of SCHOPENHAUER. T. L. D.

Tanberg, John. TEGNÉR och kemien. En studie i TEGNÉRS ställning till kemi, mineralogi och geologi. *Med hammare och fackla* 9, 139-64, 4 fig., 1939. ISIS

Chemical, mineralogical and geological knowledge of the great Swedish poet ESAIAS TEGNÉR (1782-1836). G. S.

C. — *Natural sciences*

Audubon, John James. Birds of America. With an introduction and descriptive text by WILLIAM VOGT. XXV p., 500 pls., frontispiece. New York, MACMILLAN, 1937. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 535-36, 1939.

Flower, R. Letters of THOMAS BEWICK. *British Museum Quarterly* 13, 52-54, 1939. ISIS

Herrick, Francis Hobart. AUDUBON, the naturalist : a history of his life and time. Second edition, 2 volumes in one. XCII+451 p. 56 pl. New York, APPLETON-Century, 1938. ISIS

Hey, Max H. History of the " Widmanstätten " structure. *Nature* 143, 764, 1939. ISIS

Hobbs, William H. The discovery of Antarctica : a reply to Professor R. N. RUDMOSE BROWN. *Science* 89, 580-82, 1 fig., 1939. ISIS

Krumbhaar, E. B. The centenary of the cell doctrine. *Annals of medical history* 1, 427-37, 5 fig., 1939. ISIS

North, F. J. The Ordnance geological survey : its first memoir, 1839. *Nature* 143, 1052-54, 1939. ISIS

D. — *Medical sciences*

Brunn, Walter von. Die Chirurgie unter JOHANN FRIEDRICH DIEFFENBACH, 1840-1847. *Das Universitätsklinikum in Berlin* 68-78, 1 port., 1 fig., Leipzig, BARTH, 1939. ISIS

Elliott, Jabez H. JOHN GILCHRIST, J. P., L.M.N.U.C., M.P. A pioneer New England physician in Upper Canada. *Bulletin of the history of medicine* 7, 737-50, 5 fig., 1939. ISIS

Faucci, Ugo. In memoria di AGOSTINO BASSI (1773-1856) (nel 1° centenario del " ... Mal del Segno ") (1835-1935). *Rivista di storia delle scienze* 30, 85-98, 1939 (continued from vol. 28, p. 283). ISIS

Fraatz, Paul. Der Paderborner Kreisarzt JOSEPH HERMANN SCHMIDT. Eine aktenmässige Schilderung seines Lebens und seiner Verdienste um das Medizinalwesen Westfalens sowie seiner Beteiligung an der Medizinalreform. 141 p. (*Abhandlungen zur Geschichte der Medizin und der Naturw.*, 29). Berlin, EBERING, 1939. ISIS

Laignel-Lavastine ; Girault, Louis. Rôle du service de santé militaire dans la conquête de l'Algérie (1830-1847). *Bulletin de la Société française d'histoire de la médecine* 33, 196-202, 1939. ISIS

Luckhardt, Arno B. Medical history collections in the United States and Canada. I. The Dr. WILLIAM BEAUMONT collection of the University of Chicago, donated by Mr. and Mrs. ETHAN ALLEN BEAUMONT of De Pere, Wisconsin. *Bulletin of the history of medicine* 7, 535-63, 13 fig., 1939. ISIS

McDonald, Archibald L. The aphorisms of CORVISART (1755-1821). *Annals of medical history* 1, 374-87, 471-76, 1939. ISIS

Myer, Jesse Shire (1873-1913). [A new print of] Life and letters of Dr. WILLIAM BEAUMONT. With an introduction by Sir WILLIAM OSLER. XXX+327 p., frontispiece, pls., facs., figs. St. Louis, MOSBY, 1939. ISIS

First published in 1912. The present edition contains several hitherto unpublished letters written by ALEXIS ST. MARTIN and, in addition, an evaluation by Dr. A. C. IVY of Dr. BEAUMONT's research of digestion in the human stomach in the light of present-day knowledge of this subject. Some of the dates in the book have been corrected and verified by W. SCOTT HANCOCK. I B. C.

Van Andel, M. A. De cholera morbus in 1832 te Gorinchem. *Bijdragen tot de geschiedenis der geneeskunde* 19, 153-59, 1 fig., 1939. ISIS

E. — *Alia*

Julin, Armand. La correspondance scientifique de ERNST ENGEL avec ADOLPHE QUETELET (1852-1872). *Journal de la Société de statistique de Paris*, 45, 215-21, 1 facs., 1939. ISIS

Milne, H. J. M. A positivist archive. *British Museum Quarterly* 13, 54, 1939. ISIS

Moorman, Lewis J. PERCY BYSSHE SHELLEY : tuberculosis and genius. *Annals of medical history* 1, 260-82, 1939. ISIS

Wachsmuth, Bruno. Romantische Naturwissenschaft—ihre Grundzüge und ihr Erlöschen im 19. Jahrhundert. *Klinische Wochenschrift* 18, 998-1004, München, 1939. ISIS

XIXth Century (second half)

A. — *Mathematics*

Archibald, Raymond Clare. GINO LORIA. *Osiris* 7, 5-30, port., 1939. ISIS

With elaborate bibliography. Vol. VII of *Osiris* is dedicated to GINO LORIA. G. S.

Miller, G. A. The first articles on group theory published in America. *Science* 90, 234, 1939. ISIS

Watson, E. C. A possible portrait of ARTHUR CAYLEY as an under-

graduate at Cambridge. *Scripta mathematica* 6, 32-36, 1 pl., 1939. ISIS

B. — *Physical sciences and technology*

Getman, Frederick H. IRA REMSEN (1846-1927)—erstwhile dean of Baltimore chemists. *Journal of chemical education* 16, 353-60, figs., 1939. ISIS

Guglielmini, Tito. EGIDIO POLLACCI, chimico insigne dell' ateneo pavese. *Rivista di storia delle scienze* 30, 99-102, 1939. ISIS

Jackson, Dugald C. ELIHU THOMSON: electrical engineer. *Electrical engineering* 5 p., June 1939. ISIS

La Baume Pluvinel, Aymar de (1860-1938). Notice sur ses travaux scientifiques, par F. BALDET; travaux; titres; principales publications; discours de A. COTTON et CH. MAURAIN, etc. 24 p., 1 pl. Société astronomique de France, novembre 1938. ISIS

Runge, Iris. Zur Geschichte der Spektroskopie von BALMER bis BOHR. *Zeitschrift für den physikalischen und chemischen Unterricht* H. 3, 103-13, 1 fig., 1939. ISIS

Sarton, George. BORODIN (1833-87). *Osiris* 7, 225-60, 2 port., 2 facsim., 1939. ISIS

With an appendix on *The story of Lall*, i.e., the story of the Countess LOUISE DE MERCY-ARGENTEAU, and a bibliography.

Seares, Frederich H. GEORGE ELLERY HALE. The scientist afield. *Isis* 30, 241-67, 1 pl., 1939. ISIS

Whitehead, E. S. A short account of the life and work of JOHN JOSEPH FAHIE (1846-1934). With a foreword by E. W. MARCHANT. IX+ 112 p., frontispiece. University Press of Liverpool, 1939. ISIS

This biography contains a chronological list of FAHIE's writings—on telegraphy and the history of science. In addition to his articles and books on the history of the telephone and the electric telegraph, FAHIE's labours were expended on his studies on GALILEO (*Isis* 14, 250-51). "With his passionate respect for fairness and honest thinking, he was always anxious to convince his readers not by argument, but by the clear presentation of incontestable facts. His retiring nature permitted to himself something less than justice. In these pages it is hoped that there has been revealed the extent of his knowledge as a scientist no less than the value of his researches as an historian." I B. C.

C. — *Natural sciences*

Bernard, Claude (1813-78). Pensées, notes détachées. Préface de M. le Pr. D'ARSONVAL. Introduction et notes par LÉON DELHOUME. 413 p., port. Paris, BAILLIÈRE, 1937. ISIS

First edition of a great number of thoughts of CLAUDE BERNARD on many subjects. D'ARSONVAL had been appointed BERNARD's literary executor but he postponed publication of those precious reliquiae for half a century, in order to avoid polemics such as occurred between BERTHELOT and PASTEUR apropos of BERNARD's experiments on alcoholic fermentation. These thoughts are well indexed (except the proper names !) and the editor, LÉON DELHOUME, has added 46 p. of notes. G. S.

Bernard, Claude. Philosophie, manuscrit inédit. XV+63 p. Paris, BOIVIN, s.a. (1937 ?) (15 fr.). ISIS

First edition of ms. notes written by CLAUDE BERNARD at Saint-Julien 1865-66, as a commentary on TENNEMANN's history of philosophy translated by V. COUSIN (Paris 1832) and on COMTE's *Cours de philosophie positive* (Paris 1830). It shows that BERNARD was not a positivist, nor even a determinist except in a moderate fashion. Said he (p. 51) : " Le fatalisme suppose la manifestation nécessaire d'un phénomène indépendamment de ses conditions, tandis que le déterminisme n'est que la condition nécessaire d'un phénomène dont la manifestation n'est pas forcée." He postulated the existence of a directive idea in the organization of life; how else could one understand the full development of an animal out of a single cell ? There can be no good philosophy without a scientific basis, as deep as possible in at least one direction; that basis is necessary but insufficient. One of his most startling statements is that the idea of the immortality of the soul is an experimental idea (p. 23). G. S.

Hitchens, Arthur Parker ; Leikind, Morris C. The introduction of agar-agar into bacteriology. *Journal of Bacteriology* 37, 485-93, port., 1939. ISIS

The idea of using a solid culture substrate first occurred to Frau HESSE, wife of the bacteriologist WALTHER HESSE, and was communicated to ROBERT KOCH in 1881. " KOCH recognized its value and made it his own. In 1882, in his now classic preliminary note on the tubercle bacillus, KOCH made what is the first printed reference to the use of agar—just one short sentence for a technical improvement so fundamental and epoch making. No formal paper was ever published. Thus did a modest housewife perform a service to science and to humanity. When she died in 1934, few bacteriologists knew of her death, few perhaps that she had ever lived." G. S.

Holmes, S. J. Darwinian ethics and its practical applications. *Science* 90, 117-23, 1939. ISIS

Presidential address before the Western Division of the American Association for the Advancement of Science, Stanford University, June 27, 1939.

D. — *Medical sciences*

Bett, Walter R. EDWARD WILBERFORCE GOODALL, 1861-1938. *Bulletin of the history of medicine* 7, 565-66, port., 1939. ISIS

Brunn, Walter von. Die Chirurgie unter BERNHARD VON LANGENBECK 1848-1882. *Das Universitätsklinikum in Berlin*, p. 81-92, 1 port., Leipzig, BARTH, 1939. ISIS

Brunn, Walter von. PHILIPP FRIEDRICH THEODOR MECKEL. *Ciba Zeitschrift* no. 68, p. 2380, 1939. ISIS

Doorly, Eleanor. The microbe man, a life of PASTEUR for children. Illustrated by ROBERT GIBBINGS. Introduction by PASTEUR VALLERY-RADOT. XV+154 p. Cambridge, HEFFER, 1938 (4 s. 6 d.). ISIS

The story of PASTEUR told for children by the author of that delightful book on FABRE (*Isis* 26, 531). G. S.

Drouin, Henri. La vie de PASTEUR. Paris, GALLIMARD, 1938. ISIS

Farmer, Harold. DANIEL HALE WILLIAMS, M.D., LL.D., F.A.C.S. His life and times, with some account of the first pericardiorrhaphy for wound. *Annals of medical history* 1, 252-59, 1 fig., 1939. ISIS

Gardner, Frances Tomlinson. Early California medical journals. *Annals of medical history* 1, 325-42, 14 fig. 1939. ISIS

Marshall, Mary Louise. THOMAS WADE, medical student, 1851-52. *Annals of medical history* 1, 343-50, 3 fig., 1939. ISIS

Mettenheim, H. v. Erlebnisse eines alten Arztes. Aus dem Nachlass des Dr. med. CARL V. METTENHEIMER, Geh. Med. Rates und Grossherzogl. Mecklenburg-Schwerinschen Leibarztes (1824-1898). *Archiv für Geschichte der Medizin* 32, 27-35, 1939. ISIS

Mettenheim, H. v. Zur Geschichte des ärztlichen Vereinswesens, insbesondere in Mecklenburg, und seine Förderung durch CARL METTENHEIMER. Aus seinem Nachlass dargestellt. *Archiv für Geschichte der Medizin* 32, 36-52, 1939. ISIS

Mettler, Cecilia C.; Mettler, Fred A. HENRY FRASER CAMPBELL. *Annals of medical history* 1, 405-26, 3 fig., 1939. ISIS

Reid, Edith Gittings. The life and convictions of WILLIAM SIDNEY THAYER, physician. XII+243 p., frontispiece. London, Oxford University Press, 1936. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 536-38, 1939.

Rordorf, Hartmann. Das schweizerische Apotheker-Studium vor 50 Jahren, 1883-1888. 62 p., figs. Gesellschaft für Geschichte der Pharmazie (Introduction dated 1938; received July 1939). ISIS

(**Sonntag, Ernst**; 1859-1939). Obituary by PAUL DIEPGEN. *Zentralblatt für Gynäkologie* Nr. 13, 705-08, port., 1939. ISIS

Steiner, Walter R. Some distinguished American medical students of PIERRE-CHARLES-ALEXANDRE LOUIS of Paris. *Bulletin of the history of medicine* 7, 783-93, 1939. ISIS

XXth Century

A. — *Mathematics*

Dunnington, G. Waldo. G. A. MILLER, as mathematician and man: some salient facts. *National mathematics magazine* 12, 4 p., port., 1938. ISIS

Nielsen, Niels (1865-1931). *Isis* 30, 514, 1939. ISIS

Saltykow, N. L'œuvre scientifique du Professeur Dr. M. PETROVITCH. 8 p. *Association des étudiants de mathématiques à l'Université de Belgrad*, May 1939. ISIS

B. — *Physical sciences and technology*

Darmstädter, Ernst (1877-1938). Historian of chemistry. *Isis* 30, 511-14, 1939. ISIS

Kelly, Fred C. How the WRIGHT brothers began. *Harper's magazine*, p. 473-84, October 1939. ISIS

C. — *Natural sciences*

Charcot, Jean-Baptiste (1867-1936). Numéro de Noël 1936 du *Bulletin du Yacht Club de France*. 332 p., illus. Paris, 1937. ISIS

Entirely devoted to CHARCOT. G. S.

Dawson, Warren R., editor. Sir GRAFTON ELLIOT SMITH (1871-1937). A biographical record by his colleagues. 272 p., 5 pls. London, CAPE, 1938. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 289-91, 1939.

Gardner, Nathaniel Lyon (1864-1937). Obituaries by WILLIAM ALBERT SETCHELL, in *Science* 86, 300-01, 1937 and in *Madroño* 4, 126-28, port., 1937. ISIS

Hayes, J. Gordon. The conquest of the North Pole. Recent Arctic exploration. 317 p., 16 pls., 11 maps. New York, MACMILLAN, 1934. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 538-39, 1939.

Martens, P. VICTOR GRÉGOIRE (1870-1938). *La cellule* 48, 1-46, 1939. ISIS

A biography of the distinguished cytologist. The paper includes a portrait of GRÉGOIRE, a bibliography of his scientific contribution and a bibliography of works prepared by students under his direction. C. Z.

Setchell, William Albert. Biographical memoir of MARSHALL AVERY HOWE (1867-1936). Bibliography by JOHN HENDLEY BARNHART. *National Academy of sciences of the United States of America, Biographical memoirs*, 19, 243-69, 1938. ISIS

D. — *Medical sciences*

(Cushing, Harvey, 1869-1939). A bibliography of the writings of HARVEY CUSHING. Prepared on the occasion of his seventieth birthday, April 8, 1939 by the Harvey Cushing Society. XV+108 p., frontispiece. Springfield, Ill., THOMAS, 1939. ISIS

Contents : Bibliographia animata, by ARNOLD C. KLEBS. 1. Dr. HARVEY CUSHING : Vita, degrees and honors; 2. Books and monographs; 3. Addresses, papers in journals and reports; 4. Papers from Dr. CUSHING's clinics and laboratories; 5. Appendix; 6. Subject index.

(Cushing, Harvey). HARVEY CUSHING at seventy, by HENRY R. VIETS. *New England journal of medicine* 220, 608-10, 1939. ISIS

Laignel-Lavastine. EDOUARD JEANSELME (d. 1935), historien. *Bulletin de la Société française d'histoire de la médecine* 33, 145-92, 1939. ISIS

(**Sudhoff, Karl,** 1853-1938). Obituary by WALTER ARTELT. *Janus* 43, 84-91, port., 1939. ISIS

(**Sudhoff, Karl,** 1853-1938). Obituaries by WALTER VON BRUNN, *Mitt. z. Gesch. d. Medizin, d. Naturw., u. d. Techn.* 37, 297-302, 1938; in *Deutsche medizinische Wochenschrift* 43, p. 1552, 1938; *Hippokrates* H. 44, 1129-30, 1938; *Forschungen und Fortschritte* 14, 375-76, 1938; and in *Archiv für Geschichte der Medizin* 31, 337-42, 1938. ISIS

Van Leersum, E. C. (Feb. 12, 1862-Feb. 15, 1938). In memoriam. By M. A. VAN ANDEL, *Janus* 43, 81-83, port., 1939. ISIS

E. — *Alia*

Millin, Sarah Gertrude. General SMUTS. New edition, 2 vols. London, FABER & FABER, 1939 (15 s.). ISIS

First published 1936. An excellent biography, well documented and sufficiently critical, which will remain a standard work. The Great War produced two great statesmen, WOODROW WILSON and SMUTS, neither of them European, both repudiated in part by their own people, but this is the hard fate of prophets. SMUTS was a purer WILSONIAN than the bamboozled WILSON. If his objection to the Peace had been listened to and a better treaty had thus been offered to the Germans, and if the United States had supported the League, the world would not be in the chaos it is to-day. SMUTS' intellectual life, which began with his book on WALT WHITMAN and ended with the one on Holism, shows a remarkable unity. The time will come when South Africa will be as proud of him as America is proud of LINCOLN. I have read the whole work with deep interest. G. S.

PART II

HISTORICAL AND ETHNOGRAPHICAL CLASSIFICATION

I. — ANTIQUITY

1. — **ANTIQUITY** (*generalities*)

Chapot, Victor. Sur l'emploi du bitume dans l'antiquité. *Journal des savants* 127-32, 1939. ISIS

Esser, A. Albert M. Antike Gasvergiftungen. *Archiv für Geschichte der Medizin* 32, 21-26, 1939. ISIS

Neurath, Otto. Antike Wirtschaftsgeschichte. Dritte Auflage. VI+98 p. (*Aus Natur und Geisteswelt, Samml. wissenschaftlich gemeinverständlicher Darstellungen*, 258). Leipzig, TEUBNER, 1926. ISIS

2. — EGYPT

Capart, Jean. Un chef-d'œuvre. *Chronique d'Egypte* 14, 237-44, illus., 1939. ISIS

Apropos of the admirable bust, now in the Boston Museum, of ANKH-HA-F, brother or son-in-law of KHEOPS, discovered by GEORGE REISNER. G. S.

Chatley, Herbert. Notes on ancient Egyptian astronomy. *The Observatory, a monthly review of astronomy* 62, 100-04, 1939. ISIS

" It is too soon to draw any final conclusions as to the Egyptian knowledge of astronomy. The records we have are practically all magical or religious pictures whose purpose was to protect or help the dead and only throw an indirect light on the actual observations of their inventors. The errors of copyists are frequent and misleading. It is clear, however, that the dekanal lists were revised about the beginning of the New Kingdom (say, 1600 B. C.) and it seems probable that the celestial diagram was invented then [or in 1900 B. C.] as a talisman which concentrated into one form the whole power of the heavenly bodies. The differences of the individual diagrams are too unimportant for the diagrams to have been horoscopes."

Neugebauer, Otto. Ancient Egyptian astronomy. *Nature* 143, 765, 1939. ISIS

Neugebauer, Otto ; Capart, Jean. La période sothiaque. *Chronique d'Égypte* 14, 258-62, 1939. ISIS

" Le professeur O. NEUGEBAUER a eu l'obligeance de résumer pour la *Chronique d'Égypte*, son étude publiée récemment sur la ' Période Sothiaque.' En tête de ce travail il a écrit, je suppose à l'intention de ceux dont il combat la thèse : *Lasciate ogni speranza*. Il aurait pu aussi bien dire : *Chronologia egyptiaca liberata*. En effet la démonstration du professeur NEUGEBAUER libère les études d'histoire égyptienne du véritable *Lit de Procuste* sur lequel ED. MEYER avait cru devoir les fixer."

Petrie, Sir Flinders. The making of Egypt. XV+188 p., 85 pl. London, Sheldon Press, 1939. ISIS

Petrie, Sir Flinders. Egyptian architecture. XII+95 p., 34 ill. London, British School of Archaeology in Egypt 1938. ISIS

Seston, W. L'Égypte manichéenne. *Chronique d'Égypte* 14, 362-72, 1939. ISIS

Sethe, Kurt. Uebersetzung und Kommentar zu den altägyptischen Pyramidentexten. Vols. 1 to 3. GLÜCKSTADT, 1935. ISIS

3. — BABYLONIA AND ASSYRIA

Dossin, Georges. Signaux lumineux au pays de Mari. *Revue d'assyriologie* 35, 174-86, 1938. ISIS

" Tous ces témoignages tirés des archives du Palais de Mari attestent l'existence d'un système déjà développé de signaux lumineux dans le royaume de Mari aux environs de 2000 avant J.-C. Il est surprenant que les textes cunéiformes, sumériens ou accadiens, ne nous aient encore fourni jusqu'à présent aucune indication sur le sujet. Les rois de Mari ne sont probablement pas les inventeurs des signaux lumineux, qui devaient être utilisés avant eux en Babylonie et en Mésopotamie, tant vient facilement à l'esprit l'idée de se servir de l'éclat du feu pour transmettre un message. La documentation de la correspondance de Mari nous est ainsi d'autant plus précieuse."

Neugebauer, Otto. Chronologie und babylonischer Kalender. *OLZ* 42, 403-14, 1939. ISIS

Thureau-Dangin, F. Sketch of a history of the sexagesimal system. *Osiris* 7, 95-141, 1939. ISIS

Thureau-Dangin, F. Le " grain " mesure de surface. *Revue d'assyriologie* 35, 156-57, 1938. ISIS

4. — GREECE

Blegen, Carl W. Prosymna : Remains of post-Mycenaean date. *Amer. Journal of Archaeol.* 43, 410-44, 31 figs., 1939. ISIS

Contains an illustrated description, on pp. 443-44, of a spherical sun-dial, made of marble, probably in the second century B. C., excavated at the Argive Heraeum. A. P.

Blersch, Konrad. Wesen und Entstehung des Sexus im Denken der Antike. 104 p. Tübinger Beiträge zur Altertumswissenschaft 29, 1937. ISIS

Reviewed by AUBREY DILLER, *Isis* 30, 539, 1939.

Blochet, E. De l'autonomie de l'évolution de la philosophie grecque. *Le Muséon* 47, 123-66, 297-345, 1934 ; 48, 189-226, 323-64, 1935 ; 49, 115-38, 1936. ISIS

Bortolotti, Ettore. L'infinito ed il limite nella matematica antica. *Bollettino della Unione Matematica Italiana*, p. 47-60, 1939. ISIS

Brunschwicg, Léon. Le rôle du pythagorisme dans l'évolution des idées. 25 p. (*Act. scient. et industr.* 446). Paris, HERMANN, 1937. ISIS

Caley, Earle Radcliffe. The composition of ancient Greek bronze coins. *Memoirs of the American Philosophical Society* 11, VIII+203 p., 4 pl., 5 figs. Philadelphia, 1939 ($2.50). ISIS

Very elaborate study. 1. General and historical introduction; 2. Sources and identification; 3. Experimental procedure; 4. Analysts and other collaborators; 5. Results of analyses according to localities; 6. Composition of contemporaneous Roman coins; 7. General view of the chronological variations in the proportions; 8. Possible explanations of the chronological variations; 9. General view of the nature of the minor components or impurities; 10. Microstructure; 11. Applications; 12. Conclusions.

Capparoni, Pietro. Il capitolo sulle malattie oculari in un trattato di pediatria della tarda epoca alessandrina fino ad ora sconosciuto. *Atti e Memorie dell' Accademia di Storia dell'Arte Sanitaria*, appendice alla *Rassegna di Clinica, Terapia e Scienze Affini*, 37, 6 p., 3 fig. 1938. ISIS

Apropos of a Greek physician ARCHELAOS thus far unknown. " Solamente negli scritti di GALENO è riportato una volta questo nome ARCHELAO nella citazione di una ricetta per emorroidi procidenti o per prolasso rettale : ' *Ad prolabentes podices ut Archelaus.*' Quindi questo autore deve almeno essere anteriore o contemporaneo del pergameno. H. DIELS cita manoscritti che contengono frammenti alchimistici e frammenti medici di questo ARCHELAO, e PAULY lo assegna al tempo dei giovani asclepiadi. Il trattato di pediatria, da me ritrovato, di questo medico è interessantissimo, giacchè può essere anteriore a quello di SORANO, del quale però non possediamo che frammenti. E' anche interessante per le prescrizioni terapeutiche di malattie oculari, giacchè di simili prescrizioni anteriori a lui od a lui contemporanee pochissime ne sono giunte fino a noi, salvo quelle rimasteci nelle citazioni del medico marsigliese DEMOSTENE FILARETE o DEMOSTENE L'OFTALMICO vissuto circa il 30 d.C." According to a letter kindly written to me by the author (3905.21), this treatise on eye diseases of children is identical with a text found in the first part of book IV of the medical encyclopaedia of AËTIOS OF AMIDA (VI-1) and the ascription of that text to ARCHELAOS is not proved. G. S.

Drabkin, Israel E. Notes on Epicurean kinetics. *Transactions of the American Philological Association* 69, 364-74, 2 fig., 1938. ISIS

" I. In Epicurean physics collision of atoms probably is manifested in

a reduction of velocity at impact followed by restoration of maximum atomic velocity as the new trajectory begins. This view is no less consistent with the Epicurean theory of minima of matter, space, time, and motion than is the view of a momentary cessation of motion at impact. II. The Epicurean attempt to bridge the microscopic and macroscopic worlds by a unified physical theory is here considered with particular reference to the process by which the direction and velocity of compounds are determined by the motions of the constituent atoms."

Heurtley, W. A. Prehistoric Macedonia. XXVI+275 p. Cambridge, University Press; New York, MACMILLAN, 1939 ($18.00). ISIS

This book represents the first full account of the prehistory of Greek Macedonia, although primarily it is published as a detailed record of the author's own excavations. The period dealt with runs from the Early Neolithic Age to the Early Iron Age. There are 112 figures and 23 plates. A work of permanent value. M. F. A.-M.

5. — ROME

Ducati, Pericle. Le problème étrusque. 207 p., 8 pl. Paris, LEROUX, 1938. ISIS

Reviewed by G. CH. PICARD, *Journal des savants* 134-35, 1939.

Orient, Julius. Römische chirurgische Instrumente aus dem Randgebiet Pannoniens. *Archiv für Geschichte der Medizin* 32, 136, 1 fig., 1939. ISIS

II. — MIDDLE AGES

6. — MIDDLE AGES (*generalities*)

Brunn, Walter v. Vom Aufstieg der italienischen Chirurgie im Mittelalter : *Berichte der phys.-med. Gesellschaft zu Würzburg* 61, 43-50, 1937. ISIS

Carmody, Francis J. *Physiologus latinus*; éditions préliminaires, versio B. 61 p. Paris, DROZ, 1939. ISIS

Critical edition of one of the three Latin versions of *Physiologus* (see my *Introd.* 1, 300). It includes 37 chapters, the first being *Leo* an the last *Lacerta*. G. S.

Kimble, George H. T. Geography in the Middle Ages. X+272 p., 20 pl. London, METHUEN, 1938. ISIS

Reviewed by DANA B. DURAND, *Isis* 30, 540-42, 1939.

McNeil, John T.; Gamer, Helena M. (translators). Medieval handbooks of penance : a translation of the principal " libri poenitentiales " and selections from related documents. XIV+476 p. (*Records of civilization*, 29). New York, Columbia University Press, 1938. ISIS

Sergescu, P. Les mathématiques au moyen-âge. *Le Flambeau*, 22, 405-16, 1939. J. P. ISIS

III. — ORIENTAL SCIENCE AND CIVILIZATION

8. — WESTERN ASIA

(including " The ancient East " in general)

Forbes, R. J. Gold in the ancient Near East. *Jaarbericht nº 6 van het Voor-Aziatisch-Egyptisch Gezelschap Ex Oriente Lux*, 237-54, 1939. ISIS

Ünver, A. Süheyl. Les bases du folklore médical mystique chez les Turcs. *Liječnički Vjesnik* 60, 7 p., Zagreb, 1938. ISIS

Ünver, A. Süheyl. L'idée médicale dans la poésie turque. *Liječnički Vjesnik* 60, 5 p., Zagreb, 1938. ISIS

Ünver, A. Süheyl. Quelques exemples intéressants du folklore d'Anatolie. *Türk Tib Tarihi Arkivi* 3, 4 pl., 1938 (in Turkish, with summary in French). ISIS

EASTERN ASIA

(Including works relative to the whole of Buddhist Asia, or to India, Central and Eastern Asia combined)

Gimlette, John D. A dictionary of Malayan medicine. Edited and completed by H. W. THOMSON. XVI+260 p. New York, Oxford Univ. Press, 1939. ISIS

Peake, Cyrus H. Additional notes and bibliography on the history of printing in the Far East. *Gutenberg-Jahrbuch*, p. 57-61 (received Sept. 1939). ISIS

Trilogie altindischer Mächte und Feste der Vegetation. n.d. epilogue dated 25th April, 1937. XII+238 p. (Kama) +267 p. (Bali) +339 p. (Indra) in one volume. Zurich, NIEHANS, 1937. ISIS

Reviewed by J. L. MYRES, *Journal of the Royal Asiatic Society* 296, 1939.

Weck, Wolfgang. "Kalimo usada." Ein alt-balisches Lehrbuch der Pathologie und Therapie der inneren Krankheiten. *Archiv für Geschichte der Medizin* 32, 53-93, 10 fig., 1939. ISIS

9. — INDIA

Cumming, Sir John (editor). Revealing India's past. A co-operative record of archaeological conservation and exploration in India and beyond. By twenty-two authorities, British, Indian, and Continental. With a foreword by ALFRED FOUCHER. XX+374 p., 33 pls., 3 map. London, The India Society, 1939. ISIS

We already owe to the India Society a number of very beautiful and useful publications but none more useful than this one. It is an account of the immense archaeological work done in India in every line (conservation, epigraphy, museums, publications), and in every province or state, also in Burma but not in Ceylon. There are many good illustrations including portraits of the pioneers : Sir ALEXANDER CUNNINGHAM (1814-93), JAMES BURGESS (1832-1916), Sir JOHN MARSHALL, Sir AUREL STEIN and the present leader RAO BAHADUR K. N. DIKSHIT. G. S.

Datta, Bibhutibhusan ; Singh, Avadhesh Narayan. History of Hindu mathematics : a source book. Part 2 : Algebra. XVI+314 p. Lahore, DAS, 1938. ISIS

De Terra, H. ; Paterson, T. T. Studies on the Ice Age in India and associated human cultures. XL+354 p., 54 pl. Washington, Carnegie Institution, pub. no. 493, 1939. ISIS

An important contribution to knowledge concerning the Ice Age cycle and the Pleistocene history of Stone Age man in the Himalaya, in which the geologic and archaeologic results of a 1935 expedition led by Dr. DE TERRA are set out in some detail. The study of the faunal and floral material collected by the expedition has been published or is in process of publication by other investigators. M. F. A.-M.

Pfister, R. The Indian art of calico printing in the Middle Ages : characteristics and influences. *Indian art and letters* 13, 22-33, 4 pl., 7 fig., 1939. ISIS

Poleman, Horace I. (editor). Indic studies in America. *American Council of Learned Societies, Bulletin no.* 28, VI+242 p. Washington, D.C., May 1939. ISIS

This survey of work done in the U. S. and of the facilities for further work will surprise many readers because of its richness. It will stimulate old and new students and increase the fruitfulness of their efforts. G. S.

Vogel, J. Ph. (editor). Annual bibliography of Indian archaeology, volume XII, for the year 1937. XI+136 p., 15 pls. Leyden, Kern Institute, 1939. ISIS

It is not necessary to lay stress once more upon the importance and excellence of this publication, wherein one can find easily for each year a survey of the excavations and archaeological work, not only in India but also in Afghanistan, Ceylon, Further India and Indonesia, as well as an abundant and well classified bibliography. Unfortunately, no section is devoted to the history of science. G. S.

10. — CHINA

Bodde, Derk. Types of Chinese categorical thinking. *Journal of the American Oriental Society* 59, 200-19, 1939. ISIS

Chatley, Herbert. Ancient Chinese astronomy. *Occasional notes, Royal Astronomical Society*, no. 5, 65-71, 1 pl., 1939. ISIS

Clear statement of ancient astronomy, including a tentative chronological summary of its development from c. 1500 B.C. to 350 A.D. G. S.

Gardner, Charles S. A Union list of selected Western books on China in American libraries. 2nd ed. revised and enlarged. XI+111 p. Washington, D.C., American Council of Learned Societies, 1938. ISIS

Hopkins, L. C. The rescue of the Chinese rhinoceros. *Journal of the Royal Asiatic Society* 253-60, 7 fig., 1939. ISIS

Kapferer, Richard. Der Blutkreislauf im altchinesischen Lehrbuch "Huang-Ti Nei-ching." *Münchener Medizinische Wochenschrift* 18, 718, 1939. ISIS

Maspero, Henri; Grousset, René; Lion, Lucien. Les ivoires religieux et médicaux chinois d'après la collection LUCIEN LION. Summary translated into English by LIONEL HART. 99 p., 24 pl. Paris, Les Éditions d'Art et d'Histoire, 1939. ISIS

Maspero, Henri. Les procédés de " nourrir le principe vital " dans la religion taoïste ancienne. *Journal asiatique* 229 ; 177-252, 353-430, 1937 (1st part received May 1938 ; 2nd part, Nov. 1938). ISIS

Read, Bernard E. Chinese materia medica : Dragon and snake drugs. 66 p., 6 pl. (n.d.). Turtle and shellfish drugs. 95 p. 1937. Fish drugs. 136 p. 1939. *Peking Natural History Bulletin*, Peiping, China. ISIS

12. — ISRAEL

(*Including works devoted to Palestine*)

Duesberg, Dom Hilaire. Les Scribes inspirés. Introduction aux Livres sapientiaux de la Bible. Le Livre des Proverbes. 592 p. Paris, DE BROUWER, 1938. ISIS

Reviewed by JEAN CAPART, *Chronique d'Égypte* 14, 280-81, 1939. " Ce n'est pas sans une vive satisfaction que ceux qui se consacrent à la reconstitution du passé de l'Égypte apprendront qu'un spécialiste ès matières bibliques est conduit, par ses études, à écrire au sujet du *Livre des Proverbes :* ' Il est impossible aujourd'hui de le soustraire à la mouvance de l'Égypte.' "

Frey, Jean-Baptiste. Corpus inscriptionum Judaicarum. Recueil des inscriptions juives qui vont du III^e^ siècle avant Jésus-Christ au VII^e^ siècle de notre ère. Vol. I, Europe. CXLIV+687 p., 317 pls. Rome, Pontificio Istituto di Archeologia Cristiana, 1936. ISIS

14. — ISLAM (*also Arabia*)

Berner, Alfred. Studien zur arabischen Musik auf Grund der gegenwärtigen Theorie und Praxis in Ägypten. VI+124 p. (77 letterpress + 47 music). (Schriftenreihe des Staatlichen Instituts für Deutsche Musikforschung, II). Leipzig, KISTNER und SIEGEL, 1937. ISIS

Canaan, Tewfik. The decipherment of Arabic talismans. *Berytus* 4, 69-110, 1937. ISIS

Farmer, Henry George. Studies in Oriental musical instruments. Second series. X+98 p., 4 pl. Glasgow, Civic Press, 1939. ISIS

Reprint of seven studies originally published in the *Journal of the Royal Asiatic Society* (1934-39). 1. Reciprocal influences in music 'twixt the Far and Middle East; 2. A Maghribî work on musical instruments; 3. An old

Moorish lute tutor; 4. The lute scale of AVICENNA; 5. Was the Arabian and Persian lute fretted?; 6. The instruments of music on the Ṭāq-i Bustān bas reliefs; 7. The structure of the Arabian and Persian lute in the Middle Ages. G. S.

Farrugia de Candia, J. Dénéraux en verre arabes. *Revue tunisienne* 6, 165-70, 5 fig., 1935. ISIS

Ferrand, Gabriel. Géographie et cartographie musulmanes. *Hespéris* 20, 81-84, 1935. ISIS

Hitti, Philip K.; Faris, Nabih Amin; 'Abd-al-Malik, Butrus. Descriptive catalog of the Garrett collection of Arabic manuscripts in the Princeton University Library. XII+668+XXIII p.+56 p. in Arabic. Princeton University Press, 1938 (Published October 1939). ISIS

This splendid catalog had been in process of printing at the American Press of Beirût, Lebanon, for the last four years. We are very happy to have it at last. It contains the description of some 4,500 titles, and is all that such a catalog should be. A number of chapters deal with the different branches of science. Thanks to the editors and to the Princeton University Press, Arabic scholars all over the world are given an excellent new tool to play and work with. G. S.

Howard, Harry N. Preliminary materials for a survey of the libraries and archives of Istanbul. *Journal of the American Oriental Society* 59, 227-46, 1939. ISIS

Leeuwen, Pieter Johannes van. De Maleische Alexanderroman. 344 p. Meppel, TEN BRINK, 1937. ISIS

Reviewed by C. O. BLAGDEN, *Journal of the Royal Asiatic Society*, 274-75, 1939.

Mayer, L. A. Annual bibliography of Islamic art and archaeology, India excepted. Vol. III, 1937, IX+96 p. Jerusalem, Igarta / Divan / Publishing House, 1939. ISIS

Mayer, L. A. Mamluk playing cards. *Bulletin de l'Institut français d'archéologie orientale* 38, 113-18, 5 pl., 1939. ISIS

Meyerhof, Max. Sur les noms Ibéro-Portugais des drogues dans les manuscrits médicaux arabes. *Petrus Nonius* 2, 85-96, 1939. ISIS

Mieli, Aldo. La science arabe et son rôle dans l'évolution scientifique. Avec quelques additions de HENRI-PAUL-JOSEPH RENAUD, MAX MEYERHOF, et JULIUS RUSKA. XIX+388 p. Leiden, BRILL, 1939. ISIS

Reviewed by GEORGE SARTON, *Isis* 30, 291-95, 1939.

Miollan. La médecine magique chez les Berbères. *En terre d'Islam*, 1er trim., p. 27-37, 1939. ISIS

Stark, Freya. Some pre-Islamic inscriptions on the frankincense route in southern Arabia. *Journal of the Royal Asiatic Society* 479-98, pl. 2-10, 1939. ISIS

Thaer, Clemens. Drei Bemerkungen über die Schicksale griechischer Namen bei den Arabern. *Philologische Wochenschrift* 59, 110-12, 1939. ISIS

The note deals with the corruptions of the names EUCLID, BERENICE and EUGENIOS. G. S.

Torrey, Charles C. JEFFERY's "Foreign vocabulary of the *Qur'ân*." *Moslem world* 29, 359-63, 1939. ISIS

Elaborate review by CHARLES C. TORREY, who claims that JEFFERY underestimates Jewish elements. TORREY's own views on the subject were explained in *The Jewish foundation of Islam* (New York 1933; *Isis* 21, 319-22)

Trapier, Blanche. Les voyageurs arabes au moyen âge. 253 p., 18 fig. Paris, GALLIMARD, 1937. ISIS

IV. — NEW WORLD AND AFRICA

a) AMERICA

Bergsøe, Paul. The gilding process and the metallurgy of copper and lead among the pre-Columbian Indians. 5+58 p. Copenhagen, Danmarks Naturvidenskabelige Samfund, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 542-43, 1939.

Birket-Smith, Kaj; De Laguna, Frederica. The Eyak Indians of the Copper River Delta, Alaska. 592 p., 18 pl. Copenhagen, LEVIN & MUNKSGAARD, 1938 ($6.00). ISIS

This is an important and most excellent monograph on the ethnology of a simple people which is now practically extinct. It establishes itself as the standard work on the Eyak. M. F. A.-M.

Dittrich, A. Die Finsternistafel des Dresdener Maya-Kodex. *Abhandlungen d. Preuss. Akad. d. Wiss.*, Phys.-math. Kl., 1939, Nr. 2 (Einzelausgabe), 47 p., 2 figs. ISIS

One more contribution to the literature on the Maya eclipse table in the Dresden Codex. The author, who follows in the footsteps of HANS LUDENDORFF, is convinced that he has given final mathematical proof of the correctness of SPINDEN's correlation of the Maya and European calendars. Unfortunately, numerous and serious objections to his way of reasoning could be made, so that the correlation problem must be considered as open for further discussion. The SPINDEN correlation, accepted by LUDENDORFF and by DITTRICH, fails to satisfy the *conditio sine qua non* of the Maya lunar calendar in general and of the eclipse table of the Dresden Codex in particular : the much-discussed Maya date, 9.16.4.10.8 12 Lamat 1 Muan must represent either a new moon or a full moon date. It is practically certain that 9.16.4.10.8 was an eclipse date as well—probably the date of a solar or of a lunar eclipse visible in the Maya territory. The epigraphic evidence offered by the lunar records, the so-called Supplementary Series, makes it impossible to accept a correlation which fails to identify 9.16.4.10.8 12 Lamat 1 Muan with either a new moon or a full moon date. DITTRICH has to admit, on p. 38, that SPINDEN's correlation fails to yield a new moon or a full moon date for 9.16.4.10.8 (he avoids the direct statement that on Jan. 11, A.D. 496, the age of the moon was 10 days); he repeats LUDENDORFF's statement that the moon passed the node on that date. In the GOODMAN-THOMPSON correlation—rejected by LUDENDORFF and DITTRICH—the date, 9.16.4.10.8 12 Lamat 1 Muan falls on Nov. 8, A.D. 755; this is a new moon date—an important argument in favor of the GOODMAN-THOMPSON correlation; however, the role played by this date in the eclipse chapter of the Dresden Codex was, apparently, that of a solar or of a lunar eclipse visible in the Maya territory; there was no eclipse on Nov. 8, A.D. 755. A. P.

Guzmán, Eulalia. The art of map-making among the ancient Mexicans. *Imago Mundi* 3, 1-6, 2 facs., 1939. ISIS

Henseling, Robert. The scope and antiquity of Mayan astronomy. *Research and progress* 4, 121-28, 3 fig., 1938. ISIS

Hrdlička, Aleš. Trepanation among prehistoric people, especially in America. *Ciba symposia* 1, 170-77, 1939. ISIS

Pardal, Ramón. Medicina aborigen americana. 377 p., 6 pl. (Humanior, Biblioteca del Americanista moderno, sección C : Patrimonio cultural indiano, 3). Buenos Aires, ANESI, n.d. ISIS

Reviewed by J. D. ROLLESTON, *Nature* 144, 308-09, 1939.

Steward, Julian H. Notes on HILLERS' photographs of the Paiute

and Ute Indians taken on the POWELL expedition of 1873. ***Smithsonian miscellaneous collections***, 98, no. 18, 23 p., 31 pl. Washington, D.C., Smithsonian Institution, 1939. ISIS

Wagner, Henry H. Cartography of the Northwest Coast of America to the year 1800. Two volumes in a portfolio. 1, XII+270 p., 41 maps. 2, VI+ p. 271-543. University of California Press, 1937. ISIS

Reviewed by CHARLES A. KOFOID, *Isis*, 30, 543-45, 1939.

(b) OCEANIA

Mead, Margaret. From the South Seas. New York, MORROW, 1939 ($4.00). ISIS

This volume contains three separate works published respectively in 1928, 1930, and 1935. These are *Coming of Age in Samoa*, forming pp. XXXIII+XXXV+304 p.; *Growing up in New Guinea*, p. II+384 p.; and *Sex and Temperament*, XIV+335 p. The pagination seems to have preserved that followed in the independent volumes, so that in quoting from the present volume one may quote as from the volumes independently. There has been a slight change in the section of " acknowledgements " in adaptation to the present compendious volume, and Dr. MEAD has added a preface and a new prefatory essay. As Dr. MEAD says in her preface, these three books summarise her first " ten years of grappling with the problem of how the human character is moulded by the diverse cultural settings into which human beings, cultureless and flexible, are born." As such these three books have already established their enduring value as major contributions towards an understanding of human nature. In her prefatory essay Dr. MEAD succinctly states the significance of her work for our own civilization.

M. F. A.-M.

(c) AFRICA (*outside of Egypt and Islam*)

Fontoynont ; Raomandahy. La grande Comore. 105 p., 17 illus. (*Mémoires de l'Académie Malgache*, fasc. 23). Tananarive, Imprimerie moderne de l'Emyrne, 1937. ISIS

Interesting study on the geography, history, manners and folklore of that Island located off the East African coast in lat. 12 S, long. 41 E. It was known to the ancients and to the Arabs (I just read a description of it in AL-DIMASHQĪ) and is now a French colony incorporated with Madagascar. The study could have been much better if the authors had a better knowledge of Islam and of the Arabic language. The " Vocabulaire comorien-français " contains many words which are obviously of Arabic origin, but in some of them the article has been kept, in others not. G. S.

Friedrich, Adolf. Afrikanische Priestertümer. x+391 p. Stuttgart, STRECHER u. SCHRÖDER, 1939 (RM. 20). ISIS

This is a publication in the series of *Studien zur Kulturkunde des Forschungsinstituts für Kulturmorphologie* at Frankfurt a.M. founded by the late LEO FROBENIUS. The work is subtitled " Vorstudien zu einer Untersuchung," but it is much more than that; it represents, in fact, a very thorough study of the form and distribution of Priestcraft in its two great divisions, the magical and the cult, in Africa, and as such represents a valuable contribution to the ethnology of Africa. M. F. A.-M.

Laidler, P. W. The magic medicine of the Hottentots. *South African Journal of Science* 25, 433-47, 1928. ISIS

Laidler, P. W. Native (Bantu) beliefs concerning pregnancy and child-birth. Their effects on public health administration and the effects of detribalisation or urbanisation upon those ancient customs and upon infantile mortality rates. *South African Journal of Science* 28, 418-22, 1931. ISIS

Laidler, P. W. Locations : health and sanitation. Being an extract from the *Annual Report of the Medical Officer of Health, East London*, 1st July, 1934-30th June, 1935, 11 p. East London, Griffith-Standard, 1936. ISIS

Laidler, P. W. Aesculapius and hygeia at the Cape. *South African Medical Journal* 10, 677-89, 1936. ISIS

Laidler, P. W. Medical establishments and institutions at the Cape. I. Seventeenth and eighteenth centuries ; II. During the opening years of the nineteenth century ; III. Civil hospitals, prisons and reformers ; IV. Somerset Hospital, the slave hospital and the first pauper establishment ; V. Ethics : the first S. A. Medical Society ; VI. Dr. J. ATHERSTONE and the introduction of anaesthetics ; VII. Through epidemics to reform. *South African Medical Journal*, 16 p., March 27, 1937 ; 15 p., July 10, 1937 ; 40 p., Sept. 25, 1937 ; 14 p., April 23, 1938 ; 11 p., July 9, 1938 ; 18 p., April 8, 1939. ISIS

PART III

SYSTEMATIC CLASSIFICATION

I. — SCIENCE IN GENERAL

16. — HISTORY OF SCIENCE

(American Association for the Advancement of Science). Richmond meeting (last days of 1938). Section (L) Historical and philological sciences. *Isis* 30, 563-64, 1939. ISIS

Berthelot, René. La pensée de l'Asie et l'astrobiologie. Les origines des sciences et des religions supérieures, l'astrologie chaldéenne, l'état chinois et les moralistes chinois, les philosophies indiennes, la pensée bouddhique, le monothéisme islamique et judaïque, la formation du Christianisme, dans leurs rapports avec l'astrobiologie. 383 p. Paris, PAYOT, 1938. ISIS

" Entre la représentation du monde, d'ailleurs variable et complexe, que se font les peuples sauvages (néolithiques africains, océaniens) et celle de la science moderne et de l'Occident européen, une conception intermédiaire a longtemps dominé en Asie et dans la Méditerranée orientale. C'est ce qu'on peut appeler l'*astrobiologie*. Dans l'astrobiologie, il y a une pénétration réciproque de l'idée de loi astronomique et celle de la vie végétale ou animale. D'un côté, tout serait vivant, même le ciel et les astres; de l'autre, tout serait soumis à des lois numériques, lois périodiques qui seraient à la fois des lois de nécessité et des lois d'harmonie et de stabilité (comme celles qui gouvernent les mouvements périodiques de la voûte céleste, l'alternance régulière des saisons, la reproduction annuelle des plantes). Cette conception semble s'être d'abord formulée en Chaldée et nous la rencontrons ensuite en Chine et en Grèce, où elle est sans doute d'origine chaldéenne et où elle s'est développée en des sens divergents. Car, en Chine, elle a contribué à fournir son armature intellectuelle à l'organisation de l'Empire, et, en Grèce, elle a servi de point de départ à la science arithmo-géométrique de l'école pythagoricienne et à la science médicale de l'école hippocratique : c'est-à-dire à la science même, dans les deux formes contrastées et complémentaires que lui a données l'esprit hellénique et autour desquelles s'est organisée la philosophie de l'Hellade."

Bragg, Sir William. History in the archives of the Royal Society. *Science* 89, 445-53, 1939; also in *Nature* 144, 21-28, 1939. ISIS

Pilgrim Trust Lecture, delivered before the National Academy of Sciences, April 24, 1939.

Delevsky, J. Influences diverses du milieu humain sur l'évolution des sciences. *Le mois*, no. 90, 251-57, 1938. ISIS

Delevsky, J. L'évolution des sciences et les techniques industrielles. *Revue d'histoire économique et sociale* 311-33, Paris, 1939. ISIS

Delevsky, J. L'histoire des sciences et la philosophie de l'histoire. *Travaux du IX^e Congrès international de philosophie* (Congrès Descartes), (Paris, 1-6 août, 1937). Paris, HERMANN. ISIS

Delevsky, J. L'évolution des sciences et les intérêts matériels. C'est la soif de savoir qui a été le principal stimulant du progrès des sciences exactes. *Le mois*, no. 86, 251-59, 1938. ISIS

Delevsky, J. L'intérêt économique matériel de l'homme, joue-t-il un rôle dans l'évolution des sciences? Il est difficile de le soutenir. *Le mois*, 251-60, 1937. ISIS

Dobell, Clifford. Dr. O. UPLAVICI (1887-1938). *Isis* 30, 268-72, 1939. ISIS

Biography of a scientific " ghost " published for pedagogical purposes. Remember Dr. UPLAVICI !—The editor has added a note on other scientific ghosts. G. S.

Galdston, Iago. The ideological basis of discovery. *Bulletin of the history of medicine* 7, 729-35, 1939. ISIS

Gunther, R. T. Handbook of the Museum of the history of science in the Old Ashmolean Building, Oxford. IV+157 p. University Press, Oxford, 1935. ISIS

(History of Science Society). Program of the Chicago meeting in association with the American Historical Association (December 29-30, 1938). *Isis* 30, 565-66, 1939. ISIS

(History of Science Society). Report of the secretary-treasurer. *Isis* 30, 567-72, 1939. ISIS

Jastrow, Joseph (ed.). The story of human error. XVIII+445 p., 18 pls. New York, APPLETON-Century, 1936. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 545-47, 1939.

Luckhardt, Arno B. Academic or unsuccessful research. *American journal of pharmaceutical education* 3, 165-77, 1939. ISIS

Proving the value of disinterested research. G. S.

Sarton, George. Fifty-sixth Critical Bibliography of the history and philosophy of science and the history of civilization (to November 1938—with special reference to B.C. centuries). *Isis* 30, 314-420, 1939. ISIS

This fifty-sixth bibliography contains about 650 items of which 113 deal with B.C. centuries. They have been contributed by fifteen scholars belonging to four different countries. G. S.

Sarton, George. The historical basis of philosophical unification. *Journal of unified science* (*Erkenntnis*) 9, 90-93, 1939. ISIS

Summary of a lecture delivered at the beginning of the Vth International Congress for the Unity of Science, Harvard University, Labor Day, 1939. G. S.

Sarton, George. Réponse à la question 78. Sociétés dont le nom commémore des savants illustres (*Isis* 29, 407-08). *Isis* 30, 508, 1939. ISIS

Sarton, George. Second preface to Vol. XXX. Iconographic honesty (Followed by a Bibliography of iconographic studies and a Note on altered portraits). *Isis* 30, 222-35, 1939. ISIS

Sarton, George. The history of science and the new humanism. XX+196 p. Cambridge, Harvard University Press, 1937. ISIS

Reviewed by PASQUALE ROMANELLI, *Philosophia* 3, 534-36, 1938.

(Science, history; Congress V). Cinquième congrès international d'histoire des sciences. Lausanne, septembre 1940. *Isis* 30, 516, 1939. ISIS

Trattner, Ernest R. Architects of ideas. 426 p. New York, CARRICK & EVANS, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 295-97, 1939.

West, Herbert Faulkner. The nature writers. A guide to richer reading. With a foreword by HENRY BESTON. 155 p. Brattleboro, Vt., DAYE, 1939 ($2). ISIS

An annotated list of 260 titles by authors whose writings are interpretive

of the aesthetic values of nature, informative on matters of interest in nature, and rewarding for the intellectual enjoyment of reading. C. A. K.

Whipple, Robert S. Instruments in science and industry. *Nature* 144, 461-65, 1939. ISIS

From the presidential address to Section A (Mathematical and physical sciences) of the B. A. A. S. delivered on August 31, 1939.

17. — ORGANIZATION OF SCIENCE

(*Internal organization is meant, see* Isis 1, 195.
For external organization, national or international, see section 55)

Hofstra, Sjoerd. De sociale aspecten van kennis en wetenschap. 76 p. Amsterdam, SCHELTEMA & HOLKEMA, 1937. ISIS

This useful running account of recent developments in the " science of science " deserves to be translated into some more accessible European language. Though the volume incorporates no new researches, it brings together, within brief compass, the most signal findings of English, French and German scholars in this field. A useful supplement to ERNST GRÜNWALD's *Soziologie des Wissens* (*Isis* 27, 493-503). R. K. M.

Wells, H. G. The fate of homo sapiens. An unemotional statement of the things that are happening to him now, and of the immediate possibilities confronting him. VI+330 p. London, SECKER and WARBURG, 1939. ISIS

18. — PHILOSOPHY OF SCIENCE

Delevsky, J. Les tendances dialectiques dans l'évolution de la science. *Revue philosophique* 63, 278-306, 1938. ISIS

Delevsky, J. La simplicité des lois. *Revue philosophique* 49, 232-73, 1934. ISIS

Frank, Philipp. Modern physics and common sense. *Scripta mathematica* 6, 5-16, 1939. ISIS

Kemble, Edwin C. The philosophical concepts in modern physics. Operational reasoning, reality, and quantum mechanics. *Journal of the Franklin Institute* 225, 263-75, 1938. ISIS

Organon. International review. Published by the Mianowski Institute

for the Promotion of Science and Letters. Warsaw, Poland. Editor: STANISŁAW MICHALSKI. Volume I, 1936; volume II, 1938. ISIS

Reviewed by CHARLES W. MORRIS, *Isis* 30, 297-98, 1939.

(Science, unity. Congress V). Fifth International Congress for the unity of science, Harvard University, September 5-10, 1939. Preliminary announcement. *Isis* 30, 279-80, 1939. ISIS

(Science, unity). International Institute for the unity of science. *Isis* 30, 280, 1939. ISIS

Stevens, S. S. Psychology and the science of science. *Psychological bulletin* 36, 221-63, 1939. ISIS

II. — FORMAL SCIENCES (Knowledge of forms)

19. — LOGIC AND THEORY OF KNOWLEDGE

Carnap, Rudolf. Foundations of logic and mathematics. *International encyclopedia of unified science* 1, no. 3, VIII+71 p. University of Chicago Press, 1939. ISIS

Church, Alonzo. A bibliography of symbolic logic. *Journal of symbolic logic*, 1, 121-218, 1936. Additions and corrections to same, *Journal of symbolic logic* 3, 178-212, 1938. ISIS

This is a bibliography of symbolic logic from 1666 to 1935 inclusive. It begins with the year of publication of G. W. v. LEIBNIZ, *Dissertatio de arte combinatoria* (Leipzig, 1666) and arranges the books, articles, and reviews in chronological order. This bibliography is a result of careful work and, to make it more useful, the author has included critical notes on almost all the items. There is an index of authors for the initial bibliography, while the supplement contains an index of subjects (covering the original work as well as itself) plus an index of reviews of all works listed, and an index of authors (for the supplement). This work is thus of fundamental importance for the historian of logic as well as the logician. I B. C.

Huntington, Edward V. The duplicity of logic. *Scripta Mathematica* 5, 149-57, 233-38, 1938. ISIS

Institute of general semantics. *Isis* 30, 517, 1939. ISIS

Woodger, J. H. The technique of theory construction. *International encyclopedia of unified science*, vol. 2, no. 5, VII+81 p. University of Chicago Press, 1939. ISIS

20. — MATHEMATICS

Bortolotti, Ettore. L'infinito ed il limite nel Rinascimento italiano. *Bollettino della Unione matematica italiana* 1, 275-86, 1939. ISIS

" L'inizio di una nuova fase di sviluppo, all'uscire del Medio-evo, promosso dalla divulgazione della numerazione posizionale e dalla elevazione a teoria scientifica della Regola d'algebra. LEONARDO PISANO e gli algebristi della scuola di Bologna. Le nuove correnti del pensiero scientifico. Il concetto di limite ed i primi principî della teoria del limite nelle quadrature di LUCA VALERIO e di SIMONE STEVIN."

Kowalewski, Gerhard. Der Keplersche Körper und andere Bauspiele. 65 p. (*Scientia Delectans*, 3). Leipzig, KOEHLER, 1938. ISIS

Kowalewski, Gerhard. Magische Quadrate und magische Parkette. 78 p. (*Scientia Delectans*, 2). Leipzig, KOEHLER, 1937. ISIS

(Mathematics recreation, congress). Comptes-rendus du deuxième congrès international de récréation mathématique. 103 p. Brussels, Librairie du Sphinx, 1937. ISIS

Poletti, Luigi. Un grande atlante di numeri primi depositato presso il Consiglio Nazionale delle Ricerche. *Isis* 30, 281, 1939. ISIS

Russell, Bertrand. The principles of mathematics. (Second edition). XXXIX+534. New York, NORTON, 1938. ISIS

Reviewed by H. T. DAVIS, *Isis* 30, 298-302, 1939.

Schaaf, William L. Mathematical curiosities and hoaxes. *Scripta mathematica* 6, 49-55, 1939. ISIS

Simons, Lao Genevra. FABRE and mathematics, and other essays. V+101 p. (*Scripta mathematica library*, 4). New York, *Scripta mathematica*, 1939. ISIS

Collection of four essays on the history of mathematics, three of which had already been published before. I. FABRE and mathematics (*Scripta mathematica*, 1, 208-21, 1933); II. The interest of ALEXANDER VON HUMBOLDT in mathematics; III. The influence of French mathematicians at the end of the eighteenth century (*Isis* 15, 104-23, 1931); IV. Short stories in colonial geometry (*Osiris* 1, 584-605, 1936).

Ten Doesschate, G. Uit de geschiedenis der oudste stadia van de

perspectiefleer. *Bijdragen tot de geschiedenis der geneeskunde* 18, 116-28, 3 fig., 1938 (to be cont'd). ISIS

Concerning the early study of perspective. G. S.

Thureau-Dangin, F. Sketch of a history of the sexagesimal system. *Osiris* 7, 95-141, 1939. ISIS

Revised version of *Esquisse d'une histoire du système sexagésimal* (1932). Transl. into English by SOLOMON GANDZ.

Wieleitner, Heinrich. Geschichte der Mathematik. Two vols., I. Bis 17. Jahrhundert, II. Von 1700 bis zur Mitte des 19. Jahrhunderts. 136 p., 154 p. (*Sammlung Göschen*, 226 and 875). Berlin, DE GRUYTER, 1939. ISIS

21. — STATISTICS

(*History and methods. Tables and generalities. For the applications, refer to the sciences to which they are applied*)

Willcox, Walter F. Definitions of statistics. *Revue de l'Institut international de statistique* 12 p., 1935. ISIS

III. — PHYSICAL SCIENCES (Knowledge of inorganic nature)

22. — MECHANICS (*including celestial and atomical mechanics*)

Brunet, Pierre. Étude historique sur le principe de la moindre action. 114 p. (*Actualités scientifiques et industrielles*, 693, *Publications de l'Académie internationale d'histoire des sciences*, 1). Paris, HERMANN, 1938. ISIS

To be reviewed in *Isis* by Dr. PAUL SCHRECKER.

23. — ASTRONOMY

Antoniadi, E. M. On ancient meteorites, and on the origin of the crescent and star emblem. *Journal of the Royal Astronomical Society of Canada* 33, 177-84, 2 pl., 1939. ISIS

Principally a list of citations from classical authors which are obviously descriptions of meteors or meteor showers. The second part of the paper proves that the star in the center of the crescent must be Venus. The plates are reproductions of Greek and Byzantine coins showing representations of the aerolite of Emesa and of the crescent-and-star emblem. D. N.

Astronomical Union, Sixth general assembly of the International. Stockholm, August 1938. *Isis* 30, 281, 1939. ISIS

Hartner, Willy. The principle and use of the astrolabe. Chapter 57 of ARTHUR UPHAM POPE : *A survey of Persian art.* Vol. 3, p. 2530-54, illus. Oxford University Press, 1938-39. ISIS

Hartner, Willy. The pseudoplanetary nodes of the moon's orbit in Hindu and Islamic iconographies. *Ars Islamica* 5, 113-54, 38 fig., 1938. ISIS

To the seven real planets of the ancients were added from time to time invisible and imaginary ones. The most remarkable addition of that type was the two nodes of the moon's orbit, which move around the zodiac (just like the real planets; the motion is retrograde) within eighteen and a half years. This conception is symbolized in Hindu and Muslim monuments here beautifully illustrated. G. S.

Helbig, Jean. A propos de nos cadrans solaires. *Bulletin des Musées royaux d'art et d'histoire* 11, 50-64, 20 fig., Bruxelles, 1939. ISIS

Zinner, Ernst. Die moderne Sonnenuhr, eine deutsche Erfindung. *Forschungen und Fortschritte* 15, 171-73, 1939. ISIS

24. — PHYSICS

Coremans, P. Le rôle de la Belgique dans l'histoire de la photographie. *Bull. des Musées royaux d'art et d'histoire* 11, 2-8, 5 fig., Bruxelles, 1939. ISIS

Rasetti, Franco. Il nucleo atomico. 224 p., fig. Bologna, ZANICHELLI, 1936. Also in English : Elements of nuclear physics. XIV+327 p. New York, PRENTICE-HALL, 1936. ISIS

Stevens, Blamey. The psychology of physics. XVI+282 p. Manchester, SHERRATT & HUGHES, 1939. ISIS

In this work the author " postulates the instinctive character of space, time and inertia, and deduces the physical laws of nature from the postulates." " The result of the development of the perceptual theory [a simplification of the author's previous *Identity theory*] is iconoclastic; one after another the main axiomic props of modern physics are shown to be fallacious, namely : the mass-velocity law, the equivalence of mass and total energy, the DOPPLER effect theory, special relativity, the quantum conservation theory, the cavity radiation theory, the photon theory, the electron deflection theory, the

electric divergence law, the space-time continuum and general relativity." Since the author does not wish to lay low all of physics, he introduces " perceptual equivalents " of these fallacious " axiomic props."

A sample of the author's contribution to exact knowledge is (p. 15)— " All action of one body on another at a distance from it, must be through some kind of medium, and such a medium, whatever it is, I call ether. The action must travel through the ether with the speed of light. No physicist can prove that I am wrong in this statement."

After many pages and much labor, the author concludes : " What is evidently needed is a closed circuit of cause and effect... The DARWIN-WALLACE theory of evolution by natural selection supplied a part of this circuit, but not sufficient to close it... I show that the laws of physics depend upon the psychological organization that has been evolved in man's ancestors by natural selection. Natural selection is in turn founded on the materials supplied by physics... The whole circuit of cause and effect is thus completed."

The first exercise for students (p. 268) is to " Explain briefly the postulation of the psychology." Since the author himself has been unable to do this —i.e. explain briefly—it hardly seems fair to ask the student to do it.

I B. C.

25. — CHEMISTRY, PHYSICO-CHEMISTRY, INDUSTRIAL CHEMISTRY

Barclay, A. Pure chemistry. A brief outline of its history and development. Part I—Historical review. 75 p., 14 pl. Handbook of the collections illustrating pure chemistry. Part II—Descriptive catalogue. 83 p., 14 pl., 3 fig. London, H. M. Stationery Office, 1937. ISIS

Ferchl, Fritz; Süssenguth, A. : A pictorial history of chemistry. London, HEINEMANN, 1939. ISIS

The original German edition (Mittenwald 1936) was reviewed in *Isis* 28, 262, 1936. G. S.

26. — TECHNOLOGY

(For Mining, see 32. Geology ; for Industrial chemistry, 25. Chemistry. See also Arts and Crafts under 45)

Larcher, Jorge. Amaria Portuguesa. Breves notas acêrca da sua história e terminologia. *Petrus Nonius* 2, 117-20, 1939. ISIS

Martin, Thomas W. Economics of power in Alabama. 44 p. Newcomen Society, American Branch, 1939. ISIS

Mayer, Oscar G. America's meat packing industry. A brief survey of its development and economics. 35 p. Newcomen Society, American Branch, 1939. ISIS

Newell, William Stark. Shipbuilding in Maine. A brief history. 24 p. Newcomen Society, American Branch, 1938. ISIS

Robins, F. W. The story of the lamp (and the candle). Oxford, University Press, 1939 (15 s.). ISIS

Watson, Warren N. Early fire-making methods and devices. 75 p. Washington, D.C., privately printed, 1939 (paper $1.00, cloth $1.50). ISIS

This book describes physical methods of producing fire, methods earlier than such chemical methods as are exemplified by the match, and will be of interest both to the anthropologist and to the collector. Of the six chapters—I. Fire and early man (fear, worship, use and progress), II. Wood friction (origin, distribution, methods of use; the fire drill, the fire saw, the fire thong, the fire plow), III. Percussion (oldest method, origin, distribution, how to use, devices, tinder : strike-a-light, pyrites, steel and flint, bamboo and pottery), IV. Physical methods (Malay fire piston, lens and reflector), V. Modern methods, and VI. Fire making under adverse conditions for outdoorsman—Chapters II, III, and IV are abundantly documented with pictures, mostly of apparatus in the author's own collection. The last chapter contains sound advice and useful suggestions for explorers and others who travel in the woods and wilds. T. L. D.

IV. — BIOLOGICAL SCIENCES (Knowledge of organic nature)

27. — BIOLOGY (*Generalities, "natural history"*)

Dobzhansky, Theodosius. Genetics and the origin of species. XVI+364 p., 22 figs., 22 tables. New York, Columbia University Press, 1937. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 549-51, 1939 and by CONWAY ZIRKLE, *Isis* 30, 128-31.

Hjort, Johan. The human value of biology. XII+241 p. Cambridge, Harvard University Press, 1938. ISIS

Reviewed by H. T. DAVIS, *Isis* 30, 302-04, 1939.

Pearl, Raymond. Biology. *Encyclopedia Americana* 3, 12 p., 1938. ISIS

Pearl, Raymond. Progress in the biological sciences. A university between two centuries. *The Proceedings of the* 1937 *celebration of the University of Michigan*, p. 233-59. Univ. of Michigan Press, Ann Arbor, 1937. ISIS

Waddington, C. H. An introduction to modern genetics. 441 p. New York, MACMILLAN, 1939 ($4.00). ISIS

A valuable introduction to and survey of genetical knowledge and theory at the present time. M. F. A.-M.

Wheeler, William Morton. Essays in philosophical biology. XV+261 p. Cambridge, Harvard University Press, 1939 ($3.00). ISIS

This admirable selection of the essays of WILLIAM MORTON WHEELER (1865-1937) has been very happily made by G. H. PARKER, and introduced in a Foreword by THOMAS BARBOUR. An appreciation of WHEELER by L. J. HENDERSON, THOMAS BARBOUR, F. M. CARPENTER, and HANS ZINSSER (reprinted from *Science*, June 4, 1937) follows the Foreword. ALFRED NORTH WHITEHEAD once remarked that WHEELER was the only man he had ever met who would have been both worthy and able to sustain a conversation with ARISTOTLE. The writers of the appreciation are of much the same opinion, and anyone reading these delightful essays will be inclined to agree with this high estimate. WHEELER was extraordinarily tolerant of new ideas, and continually passing them on to others. This collection of essays shows him at his best in each of these rôles, and some of his best essays, and some that are less well known, find a place in this collection. The twelve essays which make up the body of this volume are the following : The ant-colony as an organism. JEAN-HENRI FABRE. On instincts. The Termitodoxa, or biology and society. The organization of research. The dry-rot of our academic biology. Emergent evolution and the development of societies. CARL AKELEY's early work and environment. Present tendencies in biological theory. Hopes in the biological sciences. Some attractions of the field study of ants. Animal societies.

A portrait of WHEELER serves as a frontispiece, and the volume also contains a photograph of the tablet commemorating WHEELER in the Museum of Comparative Zoology at Harvard College.

Of WHEELER's place in the history of entomology this is not the place to speak; that place is among the highest, if not the highest, for WHEELER found the study of ants in a very primitive state and left it a highly organized science. Reading the present volume almost suggests that the proper study of man is entomology ! No higher praise can be given this collection of essays than to say that each one reads as if its interest would endure for ever, and I firmly believe that this little volume is destined to become a classic of its kind. M. F. A.-M.

28. — BOTANY

(Agronomy, Phytopathology, Palaeobotany)

Laufer, Berthold (1874-1934). The American plant migration : I. The potato. (Prepared for publication by C. MARTIN WILBUR). 132 p., port. Field Museum of Natural History, anthropological series 28, 1-132 (publication 418), Chicago, 1938. ISIS

Reviewed by CONWAY ZIRKLE, *Isis* 30, 551, 1939.

Mangelsdorf, P. C. ; Reeves, R. G. The origin of Indian corn and its relatives. 315 p. Texas Agric. Exp. Sta. Bulletin 574, May 1939. ISIS

Since the publication of DE CANDOLLE's *Géographie botanique* (1855) biologists have in general agreed that Indian corn *(Zea Mays)* is a New World plant, although its place of origin within the Americas has never been determined. Its wild ancestor is supposedly extinct. Because it was domesticated at a very early date and served as the principal food crop of the New World agricultural civilizations, the problem of its origin is of ethnological as well as botanical interest. In this monograph seemingly *all* of the pertinent facts are collected and applied to the solution. No brief summary of the work is possible, for it is itself a condensed collection of the evidence available in many fields. Thanks to the clarity and skill of the authors, a clear and consistent picture begins to emerge, and the generally accepted view that corn originated in or near the Yucatan peninsula may have to be revised. The authors hold that *Zea* evolved as a wild pod corn somewhere in South America from an Andropogonaceous ancestor which, in North America, gave rise to the genus *Tripsacum*. This primitive corn was domesticated and carried to Central America and Mexico by the Indians, where it came into contact with its northern relative *Tripsacum*. The hybrid which resulted spontaneously was Teosinte (*Euchlaena* sp.), a genus which has hitherto been considered independent but most closely related to *Zea*. Further crosses between *Zea* and *Euchlaena* produced the many modern varieties of maise now cultivated in favorable regions throughout the world. Of particular interest is the new cytogenetic evidence marshalled by the authors to support this hypothesis. C. Z.

Marzell, Heinrich. Zur Geschichte der Mariendistel (Silybum Marianum Gärtn.) als Heilmittel. *Archiv für Geschichte der Medizin* 32, 94-103, 1 fig., 1939. ISIS

Melhus, Irving E. ; Kent, George C. Elements of plant pathology. VII+493 p., 254 fig. New York, MACMILLAN, 1939 ($4.00). ISIS

" The *Elements of plant pathology* is an attempted solution of a practical teaching situation from the standpoint of subject matter. The chief contri-

bution of the book lies in the emphasis placed on parasitism in disease processes and the principles relating to control measures, coupled with the condensation and omission of unnecessary morphological and mycological data. In its development three obstacles had to be overcome. First, many of the students had no intention of becoming professional plant pathologists and took the course merely that they might become better farmers, teachers or agriculturists." Second, the time was very short; third, the literature to which students could be referred, insufficient. The first chapters contain historical data, and other data of that kind are scattered in the book. Our readers will remember the history of the subject by HERBERT HICE WHETZEL (Philadelphia 1918; *Isis* 5, 461-64). G. S.

Möbius, Martin. Geschichte der Botanik von den ersten Anfängen bis zur Gegenwart. VI+458 p. Jena, FISCHER, 1937. ISIS

Reviewed by CHARLES A. KOFOID, *Isis* 30, 304-06, 1939.

Moïssidès, M. Le fénugrec autrefois et aujourd'hui. *Janus* 43, 123-30, 1939. ISIS

Ockenden, Ralph E. A note on Hyoscyamus luteus. *Isis* 30, 273-76, 1 fig., 1939. ISIS

"In JEROME E. BROOKS' admirable monograph on tobacco (*Tobacco*, New York, 1937, vol. 1, p. 213), a plant described by REMBERT DODOENS under the name of *Hyoscyamus luteus* is identified as the modern *Nicotiana rustica*. If this is correct, then DODOENS was the first writer to describe this species of tobacco. In this note I wish to review the evidence in favour of this identification."

Ramsbottom, J. Historical survey of mycology. *Nature* 143, 992-93, 1939. ISIS

Extract from the Presidential address delivered to the Linnean Society of London on May 24, 1939.

Tolkowsky, S. Hesperides. A history of the culture and use of citrus fruits. XX+371 p., 113 pl., 10 fig. London, BALE, Sons & CURNOW, 1938. ISIS

This is a scholarly and extensive investigation of the history of citrus fruits and citriculture tracing the origin of the genus *Citrus* to mountains of China and India and the slow extension of its acclimatization and culture into the Levant and the Mediterranean region. Extensive use is made of the naturalistic art of the Hellenistic East, of Imperial Rome, of the Italian and French Renaissance, and of the Dutch and Flemish schools of nature painters, in tracing and dating the arrival of citrus fruits in the western world. The relations of Roman trade, the rise of Islamic culture, the Renaissance, and Spanish exploration, to the introduction and spread of citriculture are traced. The change in Jewish ritual at the Feast of Tabernacles from the

cone of the cedar to the fruit of the citron gave evidence of citriculture in Palestine in 136 B.C. Chinese, Hebrew, Arabic, and classic writings and letters are searched for records of the introduction of the word citron and the conclusion is reached that at first it had a broader connotation covering some other citrus fruits. A very exhaustive bibliography is appended. The plates are an iconography of citrus fruits in the graphic and decorative arts. C. A. K.

29. — ZOOLOGY

Baege, Bruno. Kynologische Bibliographie. Zusammengestellt im Auftrage der Forschungsstelle des Reichsverbandes für das Deutsche Hundewesen. 126 p. (Gesellschaft für Hundeforschung). Berlin, Zoolog. Garten, 1934. ISIS

Dobell, Clifford. The common flagellate of the human mouth, *Trichomonas tenax* (O.F.M.) : its discovery and its nomenclature. *Parasitology* 31, 138-46, 1 fig., 1939. ISIS

Dobell, Clifford. On "*Teranympha*" and other monstrous Latin parasites. *Parasitology* 31, 255-62, 1939. ISIS

Haskins, Caryl P. Of ants and men. VII+244 p. New York, PRENTICE-HALL, 1939 ($2.75). ISIS

This is a very good book, unusually well illustrated, on the life of the ant. Parallels are drawn between man and ant, or rather between ant and man, and although these are not always happy, they are on the whole striking enough, and the general reader for whom the book is intended will find this a most diverting book. M. F. A.-M.

Schultz, Adolph H. Notes on diseases and healed fractures of wild apes and their bearing on the antiquity of pathological conditions in man. *Bulletin of the history of medicine* 7, 571-82, 3 pl., 1939. ISIS

(Zoology, Congress XII). 12e Congrès international de Zoologie tenu à Lisbonne du 15 au 21 Septembre 1935. *Comptes rendus.* Vol. 1, XIX+228+644 p., 30 pl. Vol. 2, p. 645-1514, 41 pl. Vol. 3, p. 1515-2424, 28 pl. Lisbon, Casa Portuguese, 1936-37. ISIS

V. — SCIENCES OF THE EARTH

(implying knowledge of both organic and inorganic nature)

31. — GEOGRAPHY AND OCEANOGRAPHY

Bagrow, Leo ; Lynam, Edward (editors). *Imago Mundi*, a periodical review of early cartography. Volume III, 117 p., 8 pl., London, 1939. ISIS

This volume is completely analyzed in this 58th bibliography. G. S.

Breitfuss, L. Early maps of North-Eastern Asia and of the lands around the North Pacific. Controversy between G. F. MÜLLER and N. DELISLE. *Imago Mundi* 3, 87-99, 19 fig., 3 maps, 1939. ISIS

(Geography, congress, 16). 16th international geographical congress, 1938. *Imago Mundi* 3, 100-02, 1939. ISIS

Hobbs, William Herbert. Conditions of exceptional visibility within high latitudes, particularly as a result of superior mirage. *Annals of the Association of American Geographers* 27, 229-40, 1937. ISIS

This is important for the history of cartography, as it reveals a cause of error which has distorted many maps of Arctic regions. G. S.

Hobbs, William Herbert. The pack-ice of the Weddell Sea. *Annals of the Association of American Geographers* 29, 159-70, 1939. ISIS

Hobbs, William Herbert. The snow of outstanding mountain peaks. *Transactions of the Meetings of the International Commissions of Snow and Glaciers*, Edinburgh, September 1936. *International Association of Hydrology, Bulletin* 23, p. 715-18, 2 fig. Riga, 1938. ISIS

Stefansson, Vilhjalmur. Unsolved mysteries of the Arctic. XVI+ 381 p. New York, MACMILLAN, 1939 ($3.50). ISIS

In this very readable book STEFANSSON discusses such problems as I. the disappearance of the Greenland Colony, II. The lost FRANKLIN expedition, III. The strange fate of THOMAS SIMPSON, IV. How did ANDRÉE die? and V. The missing Soviet flyers. The book is excellently written, and throughout the manner and the style is that of the humane expert—humane, in contradistinction to the humanly jejune manner and style of the modern expert. Although the material is intrinsically fascinating of itself, STEFANSSON writes as a dispassionate scientist carefully evaluating the evidence at every step. The result is a contribution of signal value to the history of Arctic exploration. There is an introduction by STEPHEN LEACOCK, four maps, no illustrations, and a short bibliography. M. F. A.-M.

32. — GEOLOGY, MINERALOGY, PALAEONTOLOGY, MINING

(For Palaeobotany, Palaeozoology and Palaeoanthropology, see respectively, 28. Botany, 29. Zoology, and 39. Prehistory)

Lambrecht, K. (†); Quenstedt, W.; Quenstedt, A. Palaeontologi catalogus bio-bibliographicus. XXII+495 p. The Hague, JUNK, 1939. ISIS

Mather, Kirtley F.; Mason, Shirley L. A source book in geology. XXII+702 p. New York, McGRAW-HILL, 1939 ($5.00). ISIS

This splendid volume forms the fourth in the series of Source Books in the History of the Sciences under the general editorship of GREGORY D. WALCOTT, and issued with the support of the Carnegie Corporation. The three volumes already issued deal with physics, astronomy and mathematics respectively. The aim of the editors of the present volume has been to present the material " which must serve as a basis for a picture of seventeenth, eighteenth, and nineteenth century geology." Contributions later than the nineteenth century are not considered, nor has the work of living geologists been included. The editors provide brief bibliographical notes concerning the authors whom they present, and provide footnotes wherever they have considered these necessary. Since this is a source book they have very properly made no attempt to evaluate the writings represented, and point out that the student of geology will continue to depend for a consistent history of the subject upon such works as ZITTEL's *History of geology and paleontology*, GEIKE's *Founders of geology*, MERRILL's *Contributions to the history of American geology*, and ADAMS' recent *The birth and development of the geological sciences*. There is a good list of contents, and at the end of the volume a useful guide to the subject matter, and an index. The selections are chronologically arranged, and the whole volume clearly printed and well produced. There are no portraits of any of the authors represented in this volume; while such a feature would have added greatly to the value of the volume it would have presented the editors with a very difficult problem, for in many cases portraits of the authors are probably not obtainable, or obtainable only with the greatest difficulty. Still, it might have been worth trying. On the other hand, it is a question whether such illustrations do not properly belong in the formal histories of the subject. However this question may be decided we can here only congratulate the editors on bringing their Herculean task of selection and compilation to so satisfactory an end.

M. F. A.-M.

Perret, Frank A. The volcano-seismic crisis at Montserrat, 1933-1937 XII+76 p., 51 illus. Carnegie Institution of Washington, Publication no. 512, 1939. ISIS

I beg to emphasize one of the results of the author's patient and methodical

observations. "There was a response to the lunisolar influence in the majority of earthquake crises, and in this series of subvolcanic manifestations the shocks have occurred at the periods of conjunction (new moon), rather than of opposition (full moon). The great shock of November 10, 1935 which also showed abnormal characteristics on other counts, is an outstanding exception."

33. — METEOROLOGY, CLIMATOLOGY, AND TERRESTRIAL PHYSICS

Da Costa, Almirante Ramos. A influência da actividade solar na meteorologia. Historia da sua evoluçâo. *Petrus Nonius* 2, 97-103, 1939. ISIS

Shaw, Napier. The drama of the weather. XIV+307 p. Cambridge University Press, 1939 ($3.50). ISIS

Sir NAPIER SHAW is the world's leading meteorologist, and in the present volume, which is a revised and enlarged edition of the book first published in 1933, is without question the best popular introduction to the study of weather in the English language. Practically every aspect of weather is dealt with, and in a style which is at once charming and authoritative. The numerous excellently reproduced photographs and diagrams greatly assist the understanding of the text, and the many reference tables are invaluable. The whole work is exemplary, and it only remains to say that the Cambridge University Press has produced it beautifully. There is a good index. M. F. A.-M.

VI. — ANTHROPOLOGICAL AND HISTORICAL SCIENCES

(Knowledge of man, past and present)

34. — ANATOMY

Montgomery, Douglass W. The knee. *Annals of medical history* 1, 388-95, 2 fig., 1939. ISIS

Rolleston, Sir Humphry. The early history of the teaching of I. Human anatomy in London; II. Morbid anatomy and pathology in Great Britain. *Annals of medical history* 1, 203-38, 16 fig., 1939. ISIS

Wegner, Richard N. Das Anatomenbildnis. Seine Entwicklung im Zusammenhang mit der anatomischen Abbildung. 199 p. 105 fig. Basel, SCHWABE, 1939. ISIS

35. — PHYSICAL ANTHROPOLOGY

(*Anthropometry and races of man*)

Thompson, Edgar T. (editor). Race relations and the race problem. XV+338 p. Durham, N.C. ; Duke University Press, 1939 ($3.50). ISIS

A valuable and important symposium on racial problems with special reference to the American South. M. F. A.-M.

Wilton, George Wilton. Fingerprints : history, law and romance. With foreword by ROBERT HEINDL. XIX+317 p., 10 pl. London, HODGE, 1938. ISIS

36. — PHYSIOLOGY (*human and comparative*)

Gerlitt, John. The development and effects of HARVEY's theory. *Ciba Symposia* 1, 87-93, figs., 1939. ISIS

Müller-Hess, Hans Georg. Die Lehre von der Menstruation vom Beginn der Neuzeit bis zur Begründung der Zellenlehre. 102 p. (*Abhandlungen zur Gesch. d. Med. u. d. Naturw.*, 27). Berlin, EBERING, 1938. ISIS

Zürbach, Karl. Early ideas and theories on the motion of the blood. *Ciba Symposia* 1, 71-77, figs., 1939. ISIS

37. — PSYCHOLOGY (*human and comparative*)

Bachelard, Gaston. La formation de l'esprit scientifique. Contribution à une psychanalyse de la connaissance objective. 256 p. Paris, VRIN, 1938. ISIS

Dunbar, H. Flanders. Emotions and bodily changes. XLI+601 p. New York, Columbia University Press, 1938 ($5.00). ISIS

The first edition of this admirable work was published in 1935 and presented a detailed survey of the literature on psychosomatic interrelationships published between and including the years 1910 to 1933. The present second edition brings the survey up to the year 1938. Actually the work is full of historical references to the subject with which it deals, is itself historically important since it represents the first comprehensive statement of the materials and problems of the new science of psychosomatic medicine. There is a bibliography of 2358 titles, and subject and name indices. An invaluable work. M. F. A.-M.

Rogosin, H. An evaluation of extra-sensory perception. *Journal of general psychology* 21, 203-17, 1939. ISIS

38. — ARCHAEOLOGY (*generalities, methods*).
HISTORY OF ARCHAEOLOGY AND ERUDITION

Baumgärtel, E. The Gaulish necropolis of Filottrano in the Ancona Museum. *Journal of the Royal Anthropological Institute of Great Britain and Ireland* 67, 231-86, 1937. ISIS

Forbes, R. J. Archaeologie en exacte wetenschappen. *Chemisch weekblad* 36, 356-62, 1939. ISIS

Hornell, James. British coracles and Irish curraghs, with a note on the quftah of Iraq. With an introduction by Sir GEOFFREY CALLENDER. XII+p. 5-41 ; 261-304 ; 74-83 ; 148-75 ; 5-39 ; 153-59, 46 pl., figs., London, QUARITCH, 1938. ISIS

Shetelig, Haakon ; Falk, Hjalmar. Scandinavian archaeology. Translated by E. V. GORDON. VIII+435 p. New York, Oxford University Press, 1937. ISIS

39. — PREHISTORY

Breitinger, E. Gutgeheilter Unterkieferbruch aus der Frühbronzezeit. *Archiv für Geschichte der Medizin* 32, 103-10, 4 fig., 1939. ISIS

Casson, Stanley. The discovery of man : the story of the inquiry into human origins. 339 p. London, HAMILTON, 1939. ISIS

Hallström, Gustaf. Monumental art of northern Europe from the Stone Age. I : The Norwegian localities. 544+64 p., 48 pl. Stockholm, THULE, 1938. ISIS

Parry, T. Wilson. A case of primitive surgical holing of the cranium practiced in Great Britain in mediaeval times, with a note on the introduction of trepanning instruments. *Proceedings of the Royal Society of Medicine, section of the history of medicine*, 29, 14-18, 1935-36. ISIS

40. — ETHNOLOGY (*primitive and popular science*)

Allier, Raoul. La psychologie de la conversion chez les peuples non-civilisés. Tome I, Les prodromes de la crise—la crise. 595 p. Tome II, Les conséquences de la crise. 509 p. Paris, PAYOT, 1925. ISIS

Reviewed by GEORGE SARTON, *Isis* 30, 306-10, 1939.

Boas, Franz. The mind of primitive man. XI+285 p. New York, MACMILLAN, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 553, 1939.

Radcliffe-Brown, A. R. Taboo. 47 p. Cambridge, University Press, New York, MACMILLAN, 1939 ($1.00). ISIS

The Frazer lecture for 1939 by the professor of social anthropology in Oxford University, whose introduction of such new terms as " ritual value " and " ritual status " will be gratefully received by most anthropologists. M. F. A.-M.

Schmidt, Wilhelm. The culture historical method of ethnology. XXX+382 p. New York, FORTUNY'S, 1939 ($5.00). ISIS

In spite of the fact that the publisher's blurb tells us that " The English translation by Dr. SIEBER is flawless," ungracious as it may seem, I must say that this is the worst translated book from the German that I have ever encountered. It simply exacerbates. This is the more regrettable since Pater SCHMIDT's book represents the first thorough presentation of the principles and methods of the Kulturkreise School to appear in an English version. The sub-title of the book reads " The scientific approach to the racial question," and the blurb emphasizes the " racial question," but the fact is that nowhere in the book does the " racial question " make its appearance. It is certain that Pater SCHMIDT had nothing whatever to do with the subtitling of this volume. Now that Pater SCHMIDT's volume is available to English-speaking scientists, his theories are bound to receive the attention they deserve. M. F. A.-M.

Torkomian, Vahram H. Folklore obstétrical arménien. *Bulletin de la Société française d'histoire de la médecine* 33, 193-95, 1939. ISIS

Ünver, A. Süheyl. Le folklore médical de nos pays. Compte-rendu de la IVème Semaine Médicale Balkanique à Istanbul, 166-68, n.d. ISIS

Wakefield, E. G.; Dellinger, Samuel C. Possible reasons for trephining the skull in the past. *Ciba symposia* 1, 166-69, 1939. ISIS

Wallis, Wilson D. Religion in primitive society. XI+388 p. New York, CROFTS, 1939 ($5.00). ISIS

A valuable elementary account of the religious processes of primitive peoples, and a discussion of the nature of religion, by the professor of anthropology at the University of Minnesota. M. F. A.-M.

Warden, Carl J. The emergence of human culture. VI+189 p., 10 pl. New York, MACMILLAN, 1936. ISIS

Reviewed by C. A. KOFOID, *Isis* 30, 552-53, 1939.

41. — SUPERSTITION AND OCCULTISM

Sarton, George. Lunar influences on living things. *Isis* 30, 495-507, 1939. ISIS

Westaway, Frederic William. Obsessions and convictions of the human intellect. XVI+528 p., 4 pl. London, BLACKIE, 1938. ISIS

Reviewed by J. C. H., *Nature* 141, 766, 1938.

42. — ECONOMICS

(*Economic doctrines and history. Commerce. Transportation and communications*)

Taussig, F. W. Principles of economics. Fourth edition. Vol. 1, XXII+547 p.; vol. 2, XVII+595 p. New York, MACMILLAN, 1939 ($6.00). ISIS

This fourth edition of *Principles of economics* is a thoroughly revised and rewritten version of the standard introductory text to the study of economics. TAUSSIG's book has been more widely used, since its first appearance in 1911, than any text of a similar kind; it is a pity, therefore, that some of the faults of the earlier editions have not been rectified in this. Chapters 52, "Differences of wages. Social stratification.", and 68 "Socialism (II): Pros and cons" are considerably out of joint. In both these chapters the discussion of the nature of human nature is about fifty years behind present knowledge. Nonetheless, from the standpoint of the conservative teacher and the conservative reader, TAUSSIG still remains one of the pleasantest and most interesting systematic treatments of practical economics. M. F. A.-M.

Thompson, Charles Manfred; Jones, Fred Mitchell. Economic development of the United States. XIII+794 p. New York, MACMILLAN, 1939 ($3.50). ISIS

This brilliantly sound and interestingly written book has all the merits which will assure it a long life and continuing usefulness. It has been prepared for use as an introductory text in the economic history of the United States. It is to be unreservedly recommended to all growing and grown citizens of the United States, and to all others interested in these States. The extraordinarily low price at which this volume has been made available is no doubt an indication of the large sales which it is likely to enjoy.

M. F. A.-M.

43. — SOCIOLOGY, JURISPRUDENCE AND POSITIVE POLITY

Barnard, Chester I. The functions of the executive. XVI+334 p. Cambridge, Harvard University Press, 1938 ($3.50). ISIS

This is an unusual book in more ways than one. The author is that *rara avis*, a ' man of affairs ' (more exactly, president of the New Jersey Bell Telephone Company), who studies these affairs in a theoretical fashion, who examines the machinery of group organization in order to understand its operation. In this sense, and only this sense, Mr. BARNARD may be said to have written a twentieth-century Machiavellian analysis of social, primarily business, organization. Many executives have hitherto developed the practical knowledge of the empiric but they seldom conceptualized the relations between the elements of the structures in which they participated. This study is devoid of those inspirational and nonlogical generalities which so often mark the writings of the well-intentioned but uncomprehending business executive.

Cooperation, viewed as the coordinated synthesis of social, physical and biological factors, is seen to require the consensus of group participants. Formal organization is rooted in personalized, informal organizations which become the repository of common purposes, mutual understanding and group loyalties. Profiting by the work of PARETO, DURKHEIM, NORTH WHITEHEAD and his own observations, BARNARD repudiates the commonsensical view that informal organizations are an unnecessary evil and sees them rather as functionally required for stable group structure. His detailed analysis of the ' economy of incentives ' and the ' environment of decision ' is especially valuable. The book is indispensable for the student of group structure.

R. K. M.

Barnard, L. L. Social control. IX+711 p. New York, MACMILLAN, 1939 ($4.00). ISIS

This admirable text in social control treats the subject from the sociological standpoint rather than from the psychological standpoint, although the psychological and political aspects of the subject are by no means neglected. The author's head and heart are both in the right place, and as was to be expected he has produced the best book on the subject in existence.

M. F. A.-M.

Bridgman, P. W. The intelligent individual and society. VII+305 p. New York, MACMILLAN, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 310-12, 1939.

Hogben, Lancelot (ed.). Political arithmetic : a symposium of population studies. 531 p. New York, MACMILLAN, 1938. ISIS

Reviewed by ROBERT K. MERTON, *Isis* 30, 555-57, 1939.

Mumford, Lewis. The culture of cities. VII+586 p. New York, HARCOURT, BRACE, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 557-58, 1939.

44. — HISTORY OF CIVILIZATION

(*General history, historical methods, biography and chronology*)

Delevski, J. La prévision dans l'histoire humaine. *Revue philosophique* 61, 145-78, 1936. ISIS

Marvin, F. S. The new vision of man. 171 p. London, ALLEN & UNWIN, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 312-13, 1939.

Sarton, George. The unity and diversity of the Mediterranean world. *Osiris* 2, 406-63, 1936. ISIS

Reviewed by H. P. J. RENAUD, *Hespéris* 24, 347-49, 1937.

46. — HISTORY OF LANGUAGE, WRITING AND LITERATURE

Gandz, Solomon. The dawn of literature. Prolegomena to a history of unwritten literature. *Osiris* 7, 261-522, 1939. ISIS

" The present volume is an outgrowth of my paper ' The knot in Hebrew literature, or from the knot to the alphabet,' which appeared in *Isis*, vol. 14, 1930, and a condensed summary of which is here presented in chapter VII. While studying this strange phenomenon of a literature of cords and symbolic knots, the idea occurred to me to delve a little deeper into the subject, and to continue the study as an inquiry into the struggle of primitive society for the preservation of its traditions and for the development of its memory and consciousness."

Gray, Louis H. Foundation of language. XV+530 p. New York, MACMILLAN, 1939 ($7.50). ISIS

This book on the nature of language by the professor of comparative linguistics in Columbia University is intended both for the student and the general reader. It is an extremely readable, sound, and authoritative account of a difficult subject. The last chapter is devoted to " The history of the study of language." Here in some forty pages the author gives a most inadequate account of the history of the study of language. Although the names of many writers and works and periodicals are listed, there are here some of the most astonishing omissions. The faults which characterize this valuable work could all have been removed had the author seen fit to have submitted his manuscripts to the critical reading of an anthropologist versed in linguistics. There is a superb index. M. F. A.-M.

Parrington, Vernon L. Main currents in American thought. (3 vols. in 1). Vol. 1, XVII+413 p. ; vol. 2, XXII+493 p. ; vol. 3, XXXIX+429 p. New York, HARCOURT, BRACE, 1939 ($3.45). ISIS

The present volume represents the republication, between two covers as a single book, of the three volumes of the late Professor PARRINGTON's brilliant study of American literature from its beginnings up to 1920 which made their appearance between 1927 and 1930. The last volume was published posthumously. The work is now universally regarded as a classic, and it was an admirable idea of the publishers to make it available at so low a price and in so convenient a form. All three volumes are here in their original completeness, and at considerably less than the original price.

The first volume is entitled *The Colonial Mind* and deals with the period 1620-1800. The second volume bears the title *The Romantic Revolution in America*, and deals with the period 1800-1860; while the third volume is entitled *The beginnings of critical realism in America* and covers the period from 1860 to 1920. Volume three contains a thirteen-page appreciation of Professor PARRINGTON by Dr. E. H. EBY.

For the student of American culture there are few works which can equal in importance *Main currents in American thought*.

Neither on the title-page nor in relation to the colophon is there any statement of the year of publication of the present edition, although the copyright dates of the original editions are given. This is a most confusing practice which occurs only too frequently in the publications which issue from our modern publishing houses. M. F. A.-M.

48. — HISTORY OF PHILOSOPHY

(*See also above* 18. *Philosophy of science*)

Coates, Adrian. A basis of opinion. XVII+461 p. New York, MACMILLAN, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 547-49, 1939.

Dewey, John. Theory of valuation. *International Encyclopedia of Unified Science*. 2, no. 4, 67 p., University of Chicago Press, 1939. ISIS

Kauffmann, Herbert L. Bibliographie de la philosophie. Second fascicule pour l'année 1938, II. (1938) 2. IX+341 p. Paris, VRIN, 1939. ISIS

Very elaborate bibliography sponsored by the *Institut international de collaboration philosophique*, published since 1937. G. S.

Routh, H. V. Towards the twentieth century. X+392 p. New York, MACMILLAN, 1937. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 554-55, 1939.

Sorley, W. R. A history of English philosophy. XVI+380 p. Cambridge, University Press ; New York, MACMILLAN, 1937 ($2.75). ISIS

The best history of English philosophy up to the twentieth century issued in a cheap edition. Well-balanced, accurate, impartial, the book makes delightful reading. A most valuable feature is a bibliography of the writings of the philosophers dealt with; this bibliography does not claim to be exhaustive, but it is representative. There is a good index, and also a comparative chronological table. M. F. A.-M.

49. — HISTORY OF RELIGION (*Science and religion*)

Bergema, Hendrik. De boom des levens in schrift en historie. Bijdrage tot een onderzoek naar de verhouding van schriftopenbaring en traditie betreffende den boom des levens binnen het kader der oud-testamentische wetenschap (thesis, Vrije Universiteit te Amsterdam). 682 p., 127 ill. Hilversum, SCHIPPER, 1938. ISIS

Study of the traditions of the tree of life.

Born, W. Votive animals. *Ciba symposia* 1, 129-32, figs., 1939. ISIS

Coulton, G. G. Inquisition and liberty. XIII+354 p. New York, MACMILLAN, 1938. ISIS

Reviewed by M. F. ASHLEY-MONTAGU, *Isis* 30, 558-60, 1939.

Delevsky, J. L'évolution des sciences et les croyances. *Revue de synthèse* 16, 97-106, 1938. ISIS

Francesco, Grete de. Four centuries of medical votive offerings. *Ciba symposia* 1, 126-28, figs., 1939. ISIS

Francesco, Grete de. Saints in medicine. *Ciba symposia* 1, 103-17, figs., 1939. ISIS

Gerlitt, John. COSMAS and DAMIAN, the patron saints of physicians. *Ciba symposia* 1, 118-21, figs., 1939. ISIS

Gerlitt, John. Votive offerings. *Ciba symposia* 1, 122-25, figs., 1939. ISIS

Howland, Arthur C. Materials toward a history of witchcraft, collected by HENRY CHARLES LEA. 3 volumes, XLIV+1548 p. University of Pennsylvania Press, 1939 ($12.00). ISIS

For three years before his death, which occurred on the 24th October 1909 at the age of eighty-four, HENRY CHARLES LEA devoted all his time to research on the history of witchcraft. The present three volumes contain the materials which he collected and the notes he made for the work which unhappily he did not live to write. These have now been checked, organized, and arranged by ARTHUR HOWLAND in a manner which renders the work both readable and useful as a work of reference. The material here presented is by no means all that LEA hoped to collect; it is, however, very full and extensive and will serve as a valuable guide to later students of the subject. Professor GEORGE LINCOLN BURR contributes a valuable introduction of 22 pages on the scope of the work as LEA had intended to write it. An index would greatly have increased the value of the work. M. F. A.-M.

Latourette, Kenneth Scott. A history of the expansion of Christianity. Volume I, The first five centuries; Volume II, The thousand years of uncertainty, A.D. 500—A.D. 1500. XXIV+412 p.; IX+492 p. New York, HARPER, 1937, 1938. ISIS

VII. — MEDICINE

50. — HISTORY, ORGANIZATION, AND PHILOSOPHY OF MEDICINE

Birkett, Herbert S. A short account of the history of medicine in Lower Canada. *Annals of medical history* 1, 315-24, 1939. ISIS

Brunn, Walter v. Geschichtliche Einführung in die Chirurgie. *Die Chirurgie* 1, 1-32, 1939. ISIS

California's medical story in fresco at the University of California Medical School, San Francisco. 24 p., illus. San Francisco, 1939. ISIS

Gallas, Tha. Medische philatelie. *Bijdragen tot de geschiedenis der geneeskunde* 19, 203-05, 4 pl., 1939. ISIS

On medical postage stamps with 25 illustrations. G. S.

Heischkel, Edith. Die Medizingeschichtschreibung von ihren Anfängen bis zum Beginn des 16. Jahrhunderts. 91 p., 1 pl. (*Abhandlungen zur Geschichte der Medizin und der Naturw.*, 28). Berlin, EBERING, 1938. ISIS

Holzmair, Eduard. Medicina in nummis. Katalog der Sammlung Dr. JOSEF BRETTAUER, hrsg. vom Kuratorium der Dr. JOSEF BRETTAUER-Stiftung. 384 p., 25 pl. Wien, 1937. ISIS

Khairallah, Amin A. A century of American medicine in Syria. *Annals of medical history* 1, 460-70, 5 fig., 1939. ISIS

Kricker, Gottfried. Medizinische Bibliotheken in Köln. 57 p., 8 pl. (*Abhandlungen z. Gesch. d. Med. u. d. Naturw.*, 25). Berlin, EBERING, 1938. ISIS

Laignel-Lavastine, (editor). Histoire générale de la médecine, de la pharmacie, de l'art dentaire et de l'art vétérinaire. Vol. I. 681 p., figs. ; vol. II. 670 p., 469 pl., figs., Paris, MICHEL, 1936, 1938. ISIS

Leaman, William G. Medical history in clinical teaching. *Bulletin of the history of medicine* 7, 794-98, 3 fig., 1939. ISIS

McDaniel, W. B., 2d. The place of the amateur in the writing of medical history. *Bulletin of the history of medicine* 7, 687-95, 1939. ISIS

(Medicine, history ; Congress, XI). XIth Congress of the International Association for the History of Medicine. *Medicinski Pregled*, 13, 122-207, July, August, September, 1938. *Isis* 30, 278-79, 1939. ISIS

Sigerist, Henry E. Medical history in the medical schools of the United States. *Bulletin of the history of medicine* 7, 627-62, 1939. ISIS

Sigerist, Henry. Introduzione alla medicina. Traduzione dal tedesco ed introduzione di GUSTAVO BARBENSI. 365 p. Firenze, SANSONI, 1938. ISIS

Sparn, E. Cronología, diferenciación, matrícula y distribución geográfica de las sociedades de ciencias médicas. Academia Nacional de Ciencias, Córdoba (Repúbl. Argentina), 1938. ISIS

51. — EPIDEMIOLOGY, HISTORY OF SPECIAL DISEASES. PUBLIC HEALTH AND SOCIAL MEDICINE

Andrianakos, Tryphon K. Kaiserschnitt und Pyelotomie. Reform der Geburtshilfe. XII+311 p. Leipzig, BARTH, 1939. ISIS

This elaborate study on the Caesarean section is preceded by a historical account of some 60 pages well documented. The author has already written a large number of studies on gynaecology and obstetrics, most of them in Greek, some in German. His main work thus far is his " Obstetrics and gynaecology in Greece " (1375 p., Athens 1926), in Greek, including a history and bibliography of the subject in modern Greece (1800-1925). His astounding activity does credit not only to himself but also to the University of Athens. G. S.

Annecke, Kurt. Die Pestordnungen des 16. bis 18. Jahrhunderts und ihr geschichtlicher Einfluss. *Die Vorträge der Hauptversammlung in München*, Oktober 1938, Gesellschaft für Geschichte der Pharmazie, p. 1-78. ISIS

Brunn, Walther v. Wem verdankt die Welt die Erfindung und Einführung der Operation des Magenkrebses? *Zentralblatt für Chirurgie* 65, 2130-34, 1938. ISIS

Church, Franklin H. Syphilis of the center of the face. *Bulletin of the history of medicine* 7, 705-18, 7 fig., 1939. ISIS

Dittrick, Howard. The nursing can, an early American infant feeding device. *Bulletin of the history of medicine* 7, 696-704, 5 figs., 1939. ISIS

Drews, Robert S. A history of the care of the sick poor of the city of Detroit (1703-1855). *Bulletin of the history of medicine* 7, 759-82, 1939. ISIS

Gerlitt, John. The trepan. *Ciba symposia* 1, 194-96, 1939. ISIS

Kellett, C. E. The early history of gas gangrene. *Annals of medical history* 1, 452-59, 1939. ISIS

Martin, Alfred. On bathing. Oriental baths. The bath in Japan. *Ciba symposia* 1, 134-62, figs., 1939. ISIS

Robinson, Victor. Trepanation after LISTER. *Ciba symposia* 1, 187-93, 1939. ISIS

Rosen, George. Occupational diseases of English seamen during the seventeenth and eighteenth centuries. *Bulletin of the history of medicine* 7, 751-58, 1939. ISIS

Ünver, A. Süheyl ; Belger, Metiné. Sur l'histoire du paludisme dans les provinces ottomanes de Yougoslavie. *Liječnički Vjesnik* 60, 6 p., Zagreb, 1938. ISIS

Van Gils, J. B. F. Een legende over het ontstaan van de syphilis. *Bijdragen tot de geschiedenis der geneeskunde* 19, 205-09, 1 pl., 1939. ISIS

Wehrli, G. A. Trepanation in former centuries. *Ciba symposia* 1, 178-86, figs., 1939. ISIS

Wolff, Georg. Tuberculosis and civilization. Part I. Basic facts and figures in the epidemiology of tuberculosis. Part II. Interpretation of the etiological factors in the epidemiology of tuberculosis. *Human biology* 10, 106-23, 251-84, 1938. ISIS

52. — HISTORY OF HOSPITALS, OF MEDICAL TEACHING, AND OF THE MEDICAL PROFESSION. BALNEOLOGY, MEDICAL GEOGRAPHY

Beltrán, Juan Ramón. Historia del protomedicato de Buenos Aires. Buenos Aires, 1937. ISIS

Reviewed by LESLEY BYRD SIMPSON, *Isis* 30, 560, 1939.

(Gesellschaft der Aerzte in Wien). Geschichte der Gesellschaft der Aerzte in Wien, 1837-1937 hrsg. von der Gesellschaft der Aerzte : 14 fig. Vienna, SPRINGER, 1938. ISIS

Reviewed by OTTO E. GUTTENTAG, *Isis* 30, 561-62, 1939.

Napjus, J. W. De hoogleeraren in de geneeskunde aan de Hoogeschool en het Athenaeum te Franeker (1585-1843). XIV. JOHANNES HEMSTERHUIS. *Bijdragen tot de geschiedenis der geneeskunde* 19, 211-17, 1939. ISIS

Schoute, D. De stad Groningen en de geschiedenis onzer oude ziekenhuizen. *Bijdragen tot de geschiedenis der geneeskunde* 19, 172-79, 1939. ISIS

Van der Klaauw, C. J. Het eertijds verplichte instrumentarium van den heelmeester (*Mededeeling* no. 48 uit het Nederlandsch Historisch Natuurwetenschappelijk Museum te Leiden). *Bijdragen tot de geschiedenis der geneeskunde* 19, 179-89, 1939. ISIS

Van Loon, L. Het Rotterdamsche chirurgijnsgilde "S. COSMOS et DAMIANUS" van 1467-1798. *Bijdragen tot de geschiedenis der geneeskunde* 19, 193-201, 1939. ISIS

53. — PHARMACY. PHARMACOLOGY. TOXICOLOGY

Dörr, Walter. Dekorative Freundschaftsgegenstände deutscher Apotheker des 17. und 18. Jahrhunderts. *Die Vorträge der Hauptversammlung in München.* Oktober, 1938. Gesellschaft für Geschichte der Pharmazie, p. 85-98, 7 fig. ISIS

Häfliger, J. A. Apotheker und Glasgemälde. *Die Vorträge der Hauptversammlung in München,* Oktober, 1938. Gesellschaft für Geschichte der Pharmazie, p. 109-28, 11 fig. ISIS

Heymanns, Walter William. Die amerikanischen Drogen im Deutschen Arzneibuch VI. Ein Beitrag zu ihrer Geschichte im deutschen Arzneischatz. 147 p. (*Abhandlungen z. Gesch. d. Med. u. d. Naturw.*, 26). Berlin, EBERING, 1938. ISIS

Rordorf, Hartmann. Apotheker CRUSIUS und seine Getreuen. Ein Zeitbild nach den Erinnerungen eines alten Züricher Apothekers. Mit drei Zeichnungen von DAVID RORDORF-MAHLER. p. 63-111, Gesellschaft für Geschichte der Pharmazie (received July 1939) ISIS

Vrgoč, A. Historisches aus der kroatischen Pharmazie. *Die Vorträge der Hauptversammlung in München,* Oktober, 1938, Gesellschaft für Geschichte der Pharmazie, p. 129-36. ISIS

VIII. — EDUCATION (the methods of accumulating, imparting and diffusing knowledge)

54. — EDUCATION (*generalities, methods, colleges, universities*)

Durkheim, Emile. L'évolution pédagogique en France. I. Des origines à la Renaissance. 224 p.; II. De la Renaissance à nos jours. 228 p. (Bibl. de philosophie contemporaine). Paris, ALCAN, 1938. ISIS

McCall, William A. Measurement. XV+535 p. New York, MACMILLAN, 1939 ($4.00). ISIS

This is an extraordinarily good book. It is a revision of the author's *How to measure in education* which was first published in 1922. It is a pity that the earlier title was not retained, for it indicates the nature of the contents of the book far more efficiently than the present title. But that is the only quarrel we can have with what is by far and away the best book of its kind in any language. The unique thing about Professor MCCALL's book is the really moving way in which he has succeeded in humanizing a subject which is usually presented in a very pedestrian, if not trying, manner. His book is not only a very able presentation of the philosophy, methods, and manner of measurement in education, but it is also an unusually valuable contribution to the humanizing of education itself. It is an exemplary book.

M. F. A.-M.

Perdrizet, Paul. Le calendrier de la nation d'Allemagne de l'ancienne Université de Paris. XIV+120 p. (*Publications de la faculté des lettres de l'Université de Strasbourg*, 79). Paris, Les Belles Lettres, 1937. ISIS

55. — ACADEMIES, SOCIETIES, CONGRESSES, NATIONAL AND INTERNATIONAL ORGANIZATION OF SCIENCE

(*Societies and congresses devoted to particular sciences are classified under those sciences. For the internal organization of science*—Isis I, 195—*see section* 17)

Holmberg, Arne. Anteckningar om Kungl. vetenskapsakademiens bibliotek. (Mit deutscher Zusammenfassung). 47 p., illus. Stockholm, 1939. ISIS

Holmberg, Arne. Some notes on the Royal Swedish Academy of

Science (Kungl. Svenska Vetenskapsakademien). 28 p. Stockholm, 1939. ISIS

56. — BIBLIOGRAPHY (*methods, libraries*)

Leroy, Emile. Le guide pratique des bibliothèques de Paris. Préface de JULIEN CAIN. VIII+283 p. Paris, Éditions des Bibliothèques nationales de France, 1937. ISIS

Norris, Dorothy May. A history of cataloguing and cataloguing methods, 1100-1850. With an introductory survey of ancient times. With a foreword by H. M. CASHMORE. London, GRAFTON, 1939. ISIS

Walton, Clarence E. The three-hundredth anniversary of the Harvard College Library. IV+46 p., facs. Cambridge, Mass., Harvard College Library. 1939. ISIS

58. — CATALOGUES OF SECOND-HAND BOOKS ON THE HISTORY AND PHILOSOPHY OF SCIENCE

Many catalogues of second-hand books are so interesting and so full of valuable information that we shall henceforth register them in this section, together with other lists of a similar nature, such as catalogues of scientific medals and prints. When applying to the publishers of these catalogues for a copy, please mention *Isis*.

(Art Ancien). List 9, Old medicine & science, natural history (new acquisitions). Part 1, 22 p., 156 items. Zurich (2), 24 Gartenstrasse, 1939. ISIS

(Barbazán, Julián). Hispálica. Catálogo de una importante collección de obras, impresos y manuscritos, referentes a Sevilla. Bio-bibliografia y erudición, literatura, historia, arte, folklore, periódicos, mapas, guías y grabados. 48 p., 541 items. Madrid, Constantino Rodriguez 4 (received Oct. 1939). ISIS

(Bader, P. L.). Old scientific & medical books including an appendix of medical and scientific autographs. No. 15, 29 p., 183 items. Geneva, (rec'd June 1939). ISIS

(Blackwell, B. H.). Catalogue of secondhand books. Science : biological, mathematical, physical, including the library of the late

H. J. GEORGE. No. 450, 73 p., 2277 items. Oxford, 48-51 Broad St., 1939. ISIS

(**Davis & Orioli**). Rare books on many subjects including a clearance list of old medical books at very low prices. Cat. 88, 27 p., 393 items. London, W.C.1, 37 Museum St. (received July 1939). ISIS

(**Davis & Orioli**). Rare books recently acquired. Cat. 87, 34 p., 390 items. London, W.C.1, 37 Museum St. (rec'd June 1939). ISIS

(**Fiedler, Henry George**). Catalogue of scientific periodicals and publications of learned societies. Complete sets—larger runs, single volumes. No. 74, 518 items, 28 p. New York, 31-33 East 10th St., 1939/40. ISIS

(**Gilhofer & Ranschburg**). Schöne alte Bücher. Katalog 273, 40 p., 258 items. Wien 1, Bognergasse 2 (received July 1939). ISIS

(**Goldschmidt, E. P.**). Mediaeval literature, education and universities. List no. 33, 49 p., 359 items. London, W. 1, 45 Old Bond St. (received Oct. 1939). ISIS

(**Goldschmidt, E. P.**). Old books. A collection of early photographs and books commemorating the centenary of FOX TALBOT and DAGUERRE (1839-1929). Cat. no. 52, 80 p., 289 items. London, W. 1, 45 Old Bond St. (rec'd June 1939). ISIS

(**Harrassowitz, Otto**). Bibliothek THEODOR WIEGAND, Teil II : Orientalische Kunst. Nr. 474, 152 p., 2676 items. Leipzig C 1, Querstrasse 14 (received June 1939). ISIS

(**Heffer, W.**). Journals and transactions of Oriental and African learned societies. No. 557, 67 items. Cambridge, Eng., 3-4 Petty Cury (rec'd June 1939). ISIS

(**Hoosier Bookshop**). American medicine from OLIVER WENDELL HOLMES to HARVEY CUSHING, with a few incunabula and miscellanea. Introduction by JAMES F. BALLARD. List no. 71, 24 p., 230 items. Indianapolis, Ind., 2135 North Alabama (received July 1939). ISIS

(**Internationaal Antiquariaat**). English books on medicine 1550-1850 and on the history of medicine. Cat. no. 94, 41 p., 502 items Amsterdam-C, Keizersgracht 610 (received July 1939). ISIS

(**Internationaal Antiquariaat**). Medical and botanical books 16th-19th century—history of medicine. List no. 222, 162 items. Amsterdam-C, Keizersgracht 610 (received June 1939). ISIS

(**Lambert, Pierre**). Catalogue XXVI, 1re partie : Livres anciens et modernes, littérature, voyages, impressions rares, etc. 2e partie : Livres, plaquettes rares, documents pour servir à l'histoire des sciences. 57 p., 658 items. Paris, VI, Chez Durtal, 12 rue Jacob, 1939. ISIS

(**Lauria, Arthur**). Incunabula, librorum rarorum. Cat. 41, 24 p., 225 items, 35 pl. Paris, 174 Boulevard Haussmann (rec'd June 1939). ISIS

(**Lier, R.**). Summer list of early medical books. 237 items. Galluzzo (Firenze), Via S. Felice a Ema, 33, August 1939. ISIS

(**Low, David**). Old and scarce books, medicine, science & technology, transport. Cat. no. 24, 64 p., 1517 items. London, W.C.2, 17 Cecil Court, Charing Cross Road (received July 1939). ISIS

(**Luzac**). Books on the Orient. A catalogue of second-hand books on China, Japan and the Far East, Arabia and the Near East, India, Iran, etc. With an addenda of some very rare and interesting items, just purchased. No. 41, 76 p., 67 items. London, W.C.1, 46 Great Russell St., 1939. ISIS

(**Nijhoff, Martinus**). Second catalogue of publications of international congresses and conferences. No. 628. 50 p., 1404 items. The Hague (received June 1939). ISIS

(**Old Hickory Bookshop**). List no. 46, An unusual collection of books & pamphlets including many pioneer contributions of paramount importance in the growth & development of medicine & science. 106 items. New York City, 65 Fifth Ave (received Sept. 1939). ISIS

(**Poppe, Karl Max**). Botanik. Zeitschriften, Bücher, Monographien zum Teil aus dem Besitz der Herren HERM. DINGLER, G. KARSTEN, C. LAUTERBACH, H. MOLISCH, G. A. PETER. Nr. 56, 231 p., 6948 items. Leipzig C 1, Postschliessfach 100 (rec'd June 1939). ISIS

(**Rosenthal, Ludwig**). Catalogue 188, Aeronautics, Americana, geography, astronomy, medicine, natural sciences, fine arts, architecture, classics, militaria, etc. 40 p., 322 p. Den Haag, Willem de Zwijgerlaan 135, 1939. ISIS

(**Schuman's**). Seventy noteworthy medical rarities (several of medico-literary interest) in honor of the seventieth birthday of Dr. HARVEY CUSHING. Together with a tribute by LAWRENCE REYNOLDS. Cat. no. 5, 47 p. New York, 730 Fifth Ave., Autumn 1939. ISIS

(**Sotheran, Henry**). Catalogue of sets of periodicals and the publications of the learned societies and other important works suitable for libraries in science, literature and art, English and foreign. No. 860, 28 p., 285 items, London, W. 1; 2, 3, 4 and 5, Sackville St., 1939. ISIS

(**Stechert, G. E.**). Books and periodicals relating to library science and histories of libraries. No. 111, 60 p., 1476 items. New York, 31 E. 10th St. (received Oct. 1939). ISIS

(**Thiebaud, J.**). Médecine ancienne, anatomie, chirurgie, chimie et alchimie, sciences anciennes. No. 69, 96 p., 1257 items. Paris, V, 62 rue des Écoles, June 1939. ISIS

59. — MEMORIA TECHNICA

Critical bibliography no. 58. *Isis*, vol. 31. ISIS

This note is published at the end of our bibliography solely for the convenience of the scholars who cut out the whole or part of it, attach extracts to catalogue cards and classify them. By adding this note to the others they will be able to find out rapidly whether this particular bibliography has been analyzed or not.

Isis no. 81 (vol. 30, 2). Bruges, 1939. ISIS

Isis no. 82 (vol. 30, 3). Bruges, 1939. ISIS

These nos. are analyzed in the 58th Critical Bibliography. Every previous number has been analyzed in previous bibliographies.

Osiris, vol. 7 (1939). ISIS

Analyzed in the 58th Critical Bibliography. Every previous volume has been analyzed in previous bibliographies, except vol. VI not yet published (October 1939).

60. — ERRATA

Si quis Argi oculos habere posset eosque omnes diligentissime ac accuratissime intenderet in singulos versus, multa tamen eum inter corrigendum effugerent.

Isis

Vol. 30, 525. First line of Abyssinia title, read 1520, not 1530.

Osiris

Vol. 7, p. 140, l. 7, read " faithful principle which led to."
l. 9, read which for wich.

A few other misprints are not mentioned in these errata because they are too obvious to cause any error or confusion. I wish to express my thankfulness to the readers who take the trouble to make the above-mentioned corrections in their set of *Isis* and the *Introduction*. I would advise them, after having accomplished that little task, to write their initials near mine at the bottom of this note to indicate that these and the previous errata have been taken into account. G. S.

These and the previous errata have been corrected by.....

Index of Authors Included in the Fifty-eighth Bibliography

The Roman figures followed by (1) or (2) refer to the centurial classification (Part I); thus Abaelard, XII (1) means that a work by Abaelard is listed under twelfth century, first half.

The Arabic figures refer to the historical and to the systematic classifications (Parts II and III) which are subdivided in sections numbered consecutively from 1 to 60. For instance, Blegen, C. W., 4 indicates that a paper by Blegen is listed in section 4 (Greece); Bergema H., 49 indicates that a paper by Bergema is listed in section 49 (Religion).

The symbols IV(*a*), IV(*b*), and IV(*c*) refer to the new sections on America, Oceania, and Africa at the end of Part II. For instance, De Laguna, F., IV(*a*) indicates that a paper by De Laguna is listed in section IV(*a*) America.

November 16, 1939. FRANCES SIEGEL.

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